PRACTICAL ENGINEER

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PROEM

MAKING way along a hilly road, there rises ahead a crest which seems, as we mount, to cap the world. But as we achieve it, beyond rise greater heights to be attained. And so in all progress, as we win forward, ever the view broadens; ever the greater opportunity is seen.

¶ "Hold fast that which has been found good; seek the better which is ahead." That is the practical platform on which Practical Engineer is built. Therefore, the semi-monthly form which begins with this issue; therefore, the new department of Power Plant Problems; therefore, the additions to the staff of editors and contributing experts; therefore, the new Bureau of Information and Research.

¶ It is in the particular problem of power plant operation that is troubling you right now that Practical Engineer wants to be of assistance, and is prepared to give prompt help. While questions of principle and design are interesting, it is the everyday difficulty with the flash of electric current and the fizz of blue-hot steam about it that arouses most determination to conquer; it is in such that we wish to help, and, if you have conquered such a difficulty, it is that story which Practical Engineer wants.

¶ And the more you, its readers, join at the round table giving from your daily experience, the more will you, its readers, gain from the cooperation. For the spirit of good will and helpfulness begets the like, even from the Chief's desk all the way down the line.

¶ May you all prosper tremendously is the wish of the Practical Engineer staff.

ENGINE VALVE ACTION

WHAT A VALVE SHOULD DO AND A STUDY OF VALVE DIAGRAMS

IT IS NOT mere curiosity that prompts the engineer to investigate into the why of every piece of machinery under his charge, neither is he satisfied with the answer "because." Back of all machines and operations in a power plant are natural unvarying laws which must be obeyed to the letter so that the successful engineer becomes in truth a lawyer of the highest type. The following article takes up a single phase of a natural law as applied to a part of a machine and may be stated as the law of relative motion applied to the piston and valve of an engine.

For a thorough understanding of the action of engine valves it is first necessary to know just what a valve should do. The cycle of operation is first, to admit steam into the end of the cylinder behind the piston which is about ready to start on its travel to the other end of the cylinder. When the piston has gone a part of its stroke steam is cut off from the boiler by the valve and it then expands in the cylinder until the piston has almost completed its stroke when the valve opens the cylinder to exhaust. The next event for the valve in the cycle takes place just before the piston completes its return stroke, when the valve closes the steam port so that steam can no longer

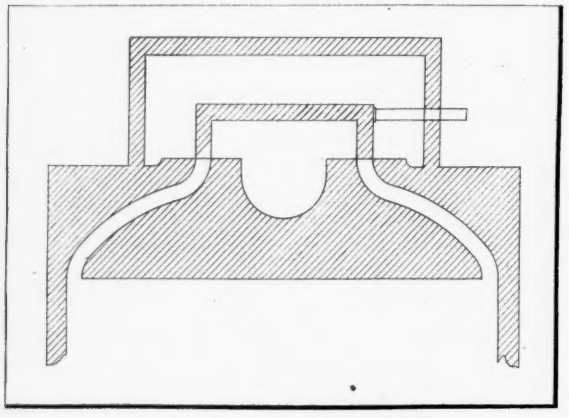


FIG. 1. D VALVE WITHOUT LAP

escape to exhaust and is, therefore, compressed and the pressure raised within the cylinder.

It is the object of the engine valve to perform each event of the cycle at the proper instant, in relation to the crank motion, in both ends of the cylinder. As might be expected, the requirements have been met more or less completely in practice, the great difficulty being to secure a valve and gear which would act instantaneously at the important events of the cycle. An explanation of the action of the simple D valve will aid in understanding the action of all valves. The plainest kind of valve, as shown in Fig. 1, has working faces of such size as just to cover the steam ports. This, of course, will not give the steam a chance to expand on the out stroke or compress on the return.

To take advantage of the expansive force of steam, it is customary to add to the valve more material to form what is called steam lap; this is the distance AD, shown in Fig. 2, and the amount varies with the class of engine. To secure compression, exhaust lap is added; this is the distance BC, Fig. 2. Having made these changes in the construction of the valve it will be seen that it can no longer be at the center of its travel when the piston is at the end of its stroke, but must have advanced in its stroke to a position where the steam port has been opened an amount called lead, as shown in Fig. 3 at A.

Bilgram Valve Diagram

TO keep clearly in the mind the relation between the positions of the valve and the piston, advantage is taken of the geometrical relations of the eccentric driving the valve and the engine crank. A brief ex-

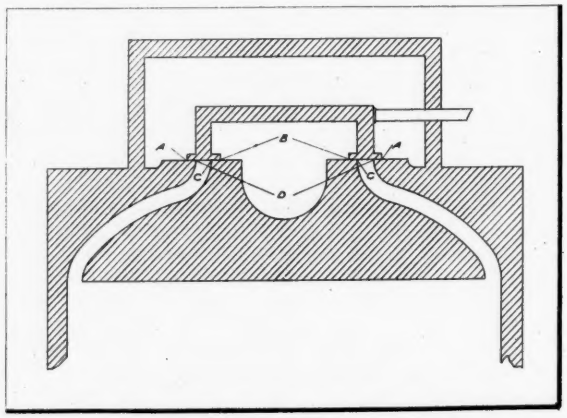


FIG. 2. D VALVE SHOWING STEAM AND EXHAUST LAP

planation of the Bilgram valve diagram will aid in making the valve action clear.

Draw a line A B, as in Fig. 4, to some convenient scale, to represent the travel of the piston; with the distance A B as a diameter draw a semicircle which will represent the path of the crank pin during one

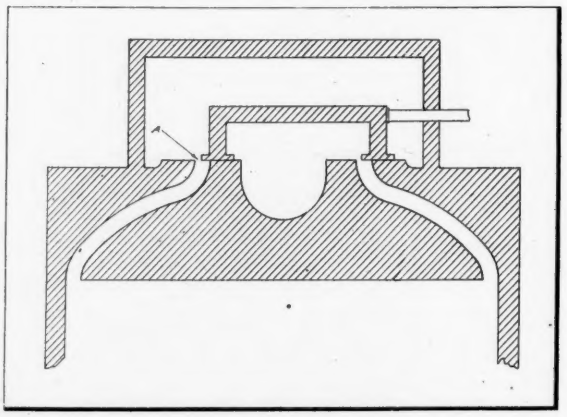


FIG. 3. VALVE OPEN THE AMOUNT OF LEAD

stroke. From the same center O and a radius equal to the radius of the eccentric, to the most convenient scale, draw a semicircle C D. Draw a line O E at an angle, a, from O B equal to the angle of advance of the eccentric, that is, the angle the eccentric has been advanced from its mid position when the piston is at the end of its stroke.

Suppose now that the piston has advanced from the position A to N. The position of the crank pin will then be in the semicircumference A B and in a line through N perpendicular to the diameter A B, or at R, the crank position will be R O and the displacement of the valve will be represented by r S which is a line drawn through r perpendicular to R O extended. No matter what the position of the piston the displacement of the valve from its central position is always represented by the perpendicular distance, to the scale of the eccentric circle, from r to the center line of the crank. So long as S falls on R O extended the valve is to the crank side of its central position, but when between R and O, the valve is nearer the head end of the cylinder. The exhaust stroke of the piston is represented by continuing the position of the crank to the under side of the line A B.

While the above diagram gives the valve displacement, it does not show the port opening, either to

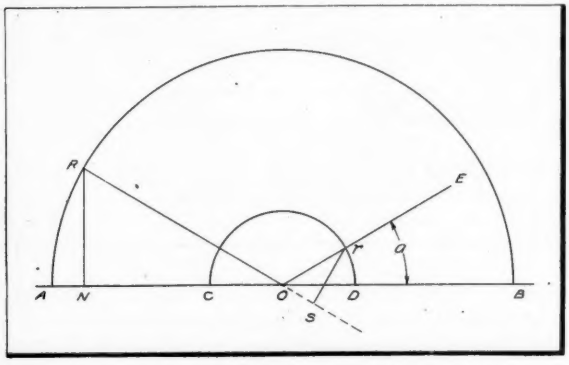


FIG. 4. BILGRAM DIAGRAM FOR LAPLESS VALVE

steam or exhaust, unless the valve be without lap, in which case r S represents both opening to steam and exhaust. By the addition of 2 circles, however, the positions of the valve and piston are made clear and all dimensions necessary can readily be obtained from the diagram. The complete diagram is shown in Fig. 5.

In this case we have drawn the complete circles, as in Fig. 4, then drawn the line to represent lead parallel to A B and above it the distance the valve has opened when the piston is on head end dead center, all dimensions being to scale. Tangent to the lead line with a radius equal to steam lap of the valve and with a center in the circumference C D, r, the steam lap circle is drawn. Using the same center and radius equal to exhaust lap the exhaust lap circle is drawn. By drawing a line O E through r, the angle of advance will be represented by E O B.

We are able now to determine the location of the piston at each important event in the cycle and also the port openings at any desired position of the piston. Thus, for any position of the crank between R_1 and R_2, the steam port opening is equal to the distance between r and the crank line minus steam lap; and between R_3 and R_4 the exhaust port is open a distance equal to the distance between r and the crank line minus the exhaust lap. This, of course, refers only to one end of the cylinder, but the other end can readily be formed by extending the crank lines.

This diagram refers directly to the D valve, but by variation is convenient in showing the action of all classes driven directly by single eccentrics. In the case of double ported valves the port opening found by the diagram should be multiplied by the width of valve and by 2 to get the area of opening.

A valve operated by an eccentric whose position is advanced or retarded by a flywheel governor has no fixed angle of advance, so to draw a diagram representing the relative position of the valve to the piston it is best to consider the governor blocked in its running position for full load and proceed as for the D valve, giving proper lead and laying off the circle representing the eccentric travel with a diameter equal to the travel of the valve. Lead is then laid off, steam lap circle is drawn as in the former case, and angle of advance determined. It may be of advantage to combine on one diagram the relations at extreme positions of the eccentric; this is done by drawing the diagram as in the former case, but using the extreme angles of advance instead of the advance for full load.

Some engine governors control by changing the throw of the eccentric and at the same time the angle of advance and diagrams for these valves should be laid off with the extreme positions of the eccentric shown on the same diagram.

In the case of Corliss or other rotary valves which may be operated by an eccentric through bell cranks, wristplates, toggle joints or the like, the usual method for showing graphically the relative positions of the valve and crank is by a line diagram of the valve gear, showing the valves in their important positions. The diagram, however, is so complicated that its use

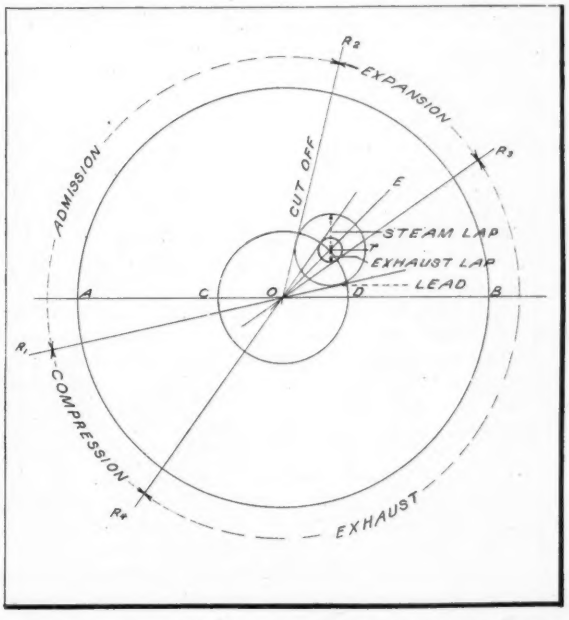


FIG. 5. COMPLETE DIAGRAM FOR D VALVE

in the power plant is not advisable, as the action can be more readily and accurately obtained by shifting the eccentric and observing the valve positions.

Effects of Angularity

IN all the above cases no account has been taken of the effects of angularity of either the connecting rod or eccentric rod. Considering the connecting rod, it will be seen from Fig. 6 that the piston will move through a greater distance while the crank goes through its first and fourth quarter revolution than during its second and third, the amount depends upon the ratio of the crank diameter to the connecting rod; the more nearly the crank diameter equals the length of the connecting rod the greater the distortion. In

the present case the difference in travel is equal to twice the distance between C and 2 on the line M N.

The effect of this angularity is to retard cutoff by an amount A B on the head end, as will readily be seen in Fig. 6, and on the crank end to advance cutoff the distance D E. Other important events are not greatly affected since the crank is so near the center line of the cylinder.

Effects of angularity of eccentric rod are described in an article by Mr. McGahey, published in this issue and will not be discussed here.

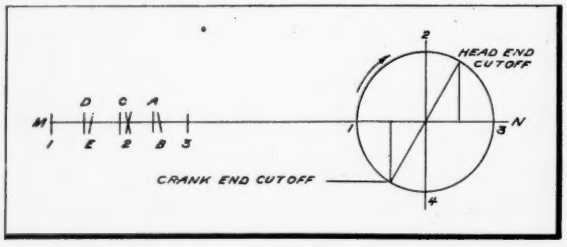


FIG. 6. EFFECTS OF CONNECTING ROD ANGULARITY

Travel of the valve has a great deal to do with its operation; thus increasing the travel brings admission earlier and continues it longer, making expansion begin later and cease earlier; the effect on exhaust is to open earlier and continue longer, thus shortening the period of compression, which begins later and ceases earlier.

The successful operation of steam engine valves depends largely upon the rapidity with which the valve moves when admitting steam to the cylinder, also at cutoff and release. Theory requires that these events take place instantaneously in order that no wire drawing be encountered. To secure this result many designs of valves and valve gears have been brought out, among them being the double ported D valve, the gridiron valve, rotary valves with quick acting and releasing gear, etc.

While the objects to be obtained by engine valves may be stated clearly and in but few words, the means employed are quite complicated in many of our best engines and the effects of varying adjustments lead one all the way from failure to success in steam engineering.

AS SHOWING WHAT may be done to boilers by river waters, the report of the Geological Survey on Some Stream Waters of the Western United States is convincing. The Colorado River carries in solution, during a year, 4,550,000 tons of common salt; 3,740,000 tons of Glauber's salt; 4,000,000 tons of lime; 2,400,000 tons of Epsom salts; and 2,400,000 tons of gypsum; besides 338,000,000 tons of mud and suspended matter.

Even at that, the water isn't so very bad, for there is lots of water. But it means that 20 tons of salt is soaked out of each square mile of land drained; yet the Elm Fork of the Red River takes 1680 tons of salt per square mile drained, and we wonder where all the scale comes from. Such water as the Red River furnishes might seem good supply for the brine coils of an ice plant, but hardly for boiler feed or irrigation purposes.

These are only examples, but they show that a study of the report which is Water Supply Paper No. 274 is likely to prove of benefit to any engineer who has to deal with western river waters.

DETERMINATION ACCOMPLISHES more than mere intelligence.—J. S. McMillan.

TYPES OF STEAM ENGINE VALVES

THEIR CLASSIFICATION AND CHARACTERISTICS

ENGINE valves may be classified under 4 headings: slide, piston, rotary and poppet valves.

The most common valve, particularly for small and medium size engines which run at high speed, is the slide valve. This is the simplest form of valve used for engines and posseses all the necessary features although it lacks some of the refinements possessed by some other types of valves. The action of the D valve is taken up in a preceding article in detail and will not be discussed further.

Closely related to the D valve is the Sweet valve. The characteristics of this valve are a double steam port which gives double area of opening with the

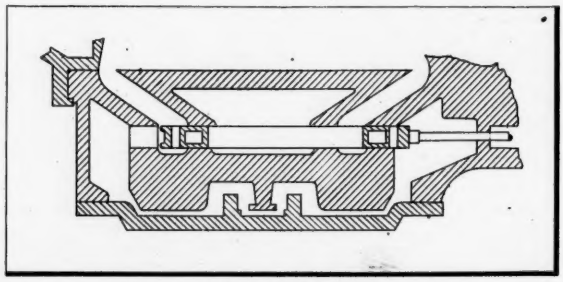


FIG. 1. VIEW OF THE SWEET VALVE

same valve displacement possessed by the D valve and balancing of pressure. This feature overcomes slow admission and cutoff, which are characteristic of the D valve. The Sweet valve is operated by a single eccentric, the same as the mechanism used for the D valve, and only one valve is required to operate the engine.

What is known as a gridiron valve for steam engines has the form of a gridiron or grate and slides

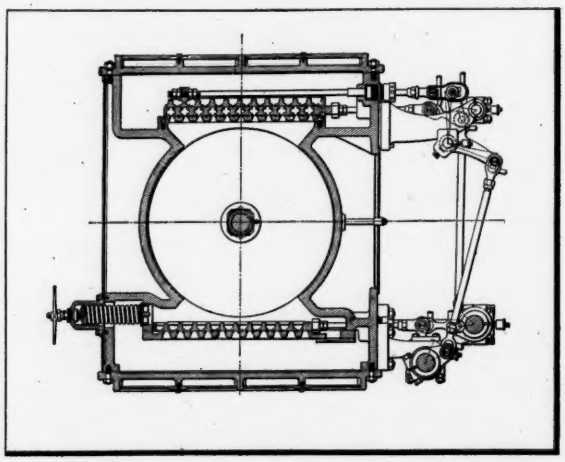


FIG. 2. GRIDIRON VALVES FOR ENGINES

over a similar grated seat. This form is such that it requires a steam and exhaust valve for each end of the cylinder thus making in all 4 valves for the engine. The advantage of this type over the common D valve is to give a quick opening and closing with large area of port opening during the period steam is flowing to the cylinder, also to increase the speed of the cutoff and vary the range of cutoff for different loads. The steam valves are usually driven by some form of re-

leasing gear, under the control of the governor, and are closed by means of a dashpot or spring.

Another form of slide valve is equipped with a riding cutoff arrangement, the main valve having a form similar to the D valve but with steam admitted through ports in the valve and over these slides the cutoff arrangement, which closes the valve steam port at the desired time of cutoff. Main and cutoff valves are driven by separate eccentrics, that which operates the main valve being fastened rigidly to the shaft

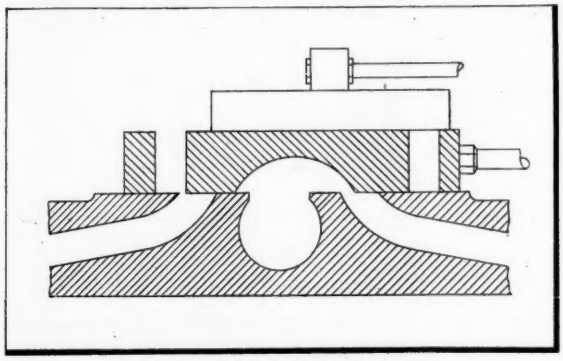


FIG. 3. RIDING CUTOFF VALVE

while that operating the cutoff valve is controlled in its position by the governor, thus changing the length of cutoff to suit the load. By this arrangement all events of the main valve take place at the same point in the stroke while cutoff is controlled entirely by the governor and varied to suit the load upon the engine.

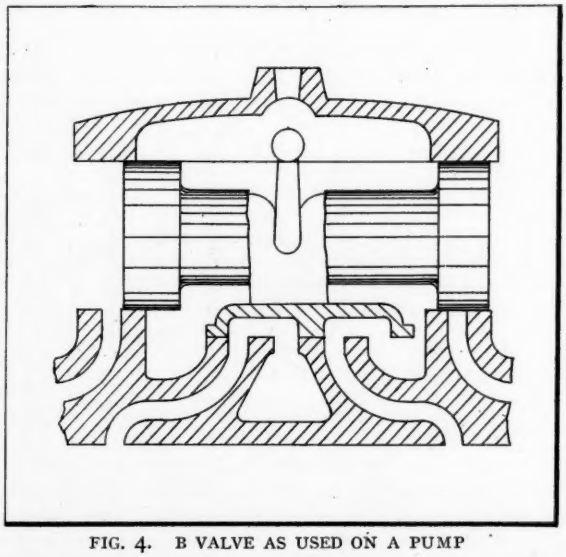


FIG. 4. B VALVE AS USED ON A PUMP

The function of the cutoff valve being to control this event in the cycle, the main valve is made with little or no steam lap though other proportions of the main valve are similar to that of the D valve. The advantage obtained by the use of riding cutoff valves is that the speed of the engine is not controlled by throttling but by cutoff thus obtaining full advantage of the expansion of steam during all loads of the engine. A further advantage is that cutoff occurs rapidly thus reducing wire-drawing at this point to the least possible.

A form of slide valve frequently used on direct connected steam pumps takes the shape of a B, which will be noted in Fig. 4. In this case the steam space is above the valve and when the valve is at the end of its travel, the steam passes around under the end of the valve to the steam port, and exhaust from the other end of the cylinder goes out through the steam port and is directed to the exhaust port by the valve. These valves are made without lap since direct acting pumps cannot use steam expansively.

Piston Valves

IN seeking to reduce the friction encountered in the ordinary slide valve, the piston valve has been devised, which, in its simple form, does not differ greatly from the common slide valve except that instead of having a flat working surface it is made circular and

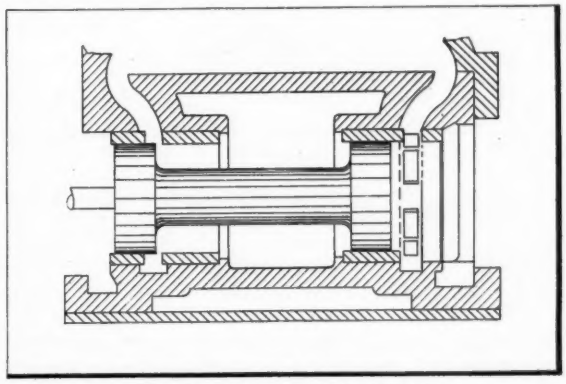


FIG. 5. SIMPLE PISTON VALVE

the common arrangement is to have the steam space at the middle of the valve with exhaust at the end. As stated, the great advantage of this valve over the common D valve is the ease with which it can be balanced, thus requiring little force to operate it.

Piston valves may also be equipped with double ports as is shown in Fig. 6, this type being used in some 4-valve engines. The advantages of this arrangement are rapid opening and closing of the valve, and, at the same time, perfect balance.

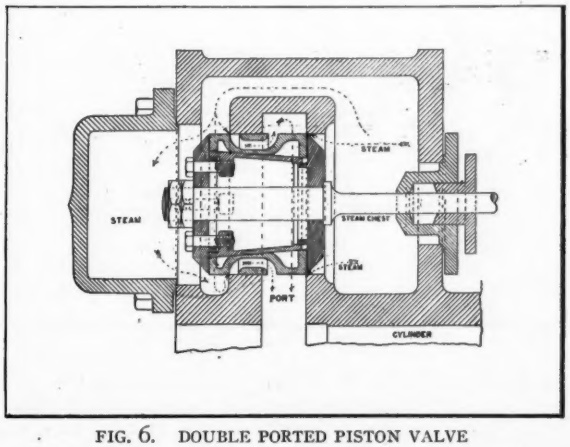


FIG. 6. DOUBLE PORTED PISTON VALVE

Corresponding to the riding cutoff valve is the Rider valve, sections of which are shown in Fig. 7. The main valve here is in the form of a cylinder with ports helical in shape. The riding valve has the form of a circular wedge, thus by rotating the cutoff valve slightly it can be made to vary the time at which it covers the ports in the main valve thus changing the position of cutoff. By this arrangement the valve becomes balanced, at the same time giving the advantage of governor control by cutoff.

Another form of cutoff piston valve is that shown in Fig. 8. The main valve is closed at its outer end and the 2 parts are connected together by bars as shown. The cutoff valve is a round valve, and works within the main valve, which is also cylindrical, its stem passing through the hollow valve stem of the main valve. The seat consists of a bushing placed in

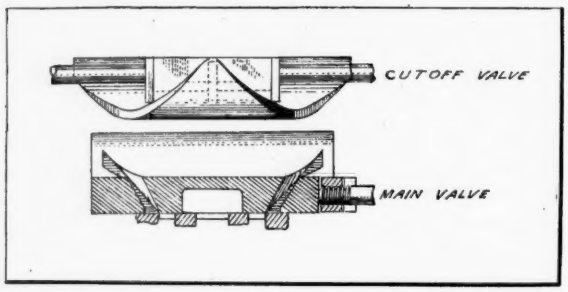


FIG. 7. SECTIONS OF THE RIDER VALVE

the casting. Steam is admitted to the cylinder from the interior of the main valve, and exhaust is from the end.

Rotary Valves

ALL rotary valves are similar to the Corliss valve or some modification of it. Several forms of these valves are shown in Fig. 9. Engines employing rotary valves are equipped with 2 for steam and 2 for exhaust, all being oscillated about their axes and each having but one working edge, except in the case of double ported valves which have 2. As a rule rotary valves extend the full width of the cylinder, require but short travel and give a large area of opening. Each valve being separately connected to the wristplate the adjustments in setting the valves are made simple since any change made in the adjustment of one valve will not affect the others.

The first method of operating rotary valves to secure a quick cutoff was by means of a releasing

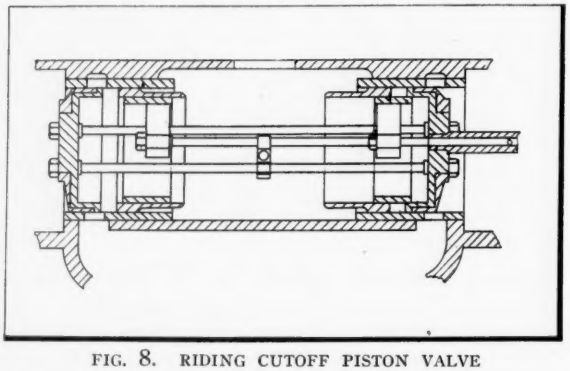


FIG. 8. RIDING CUTOFF PISTON VALVE

mechanism which was under the control of the governor, the valve being closed by means of a dashpot. This form has been very popular and is used in many of the best heavy duty engines today. A more recent development is the nonreleasing gear movement employing quick acting links in such a manner as to give the steam valve rapid action at admission and cutoff and slow movement at other points of the valve stroke.

Poppet Valves

POPPET valves have been used to some extent in engine construction for slow and medium speeds, and possess a number of valuable features but have not been found applicable to high-speed engines.

Two types of poppet valves are adaptable to steam engines, these being single and double seated valves. It is necessary in either case to have the valves balanced and the form they take is usually somewhat different from the common poppet valve, a good example is that shown in Fig. 10, which represents the steam and exhaust valves at one end of the cylinder

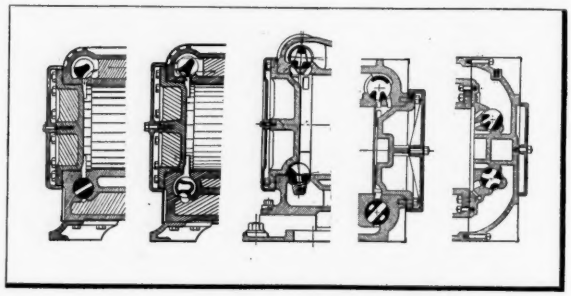


FIG. 9. FORMS OF ROTARY VALVES

of a Frisbie engine. The steam valve is shown to the right and takes the form of a cylinder fitted with rings and operates inside another cylinder. The valve has a collar around the bottom which is of sufficient area, when acted upon by steam pressure, to give the valve a firm seating which is also aided by a spring. The exhaust valve is of a different form since the pressure is all from within the cylinder, the valve is bored out to fit over a cylindrical projection from the valve jet cover, which is provided with rings and is a little smaller in diameter than the valve seat. The valves are mechanically operated from cams to give the proper cutoff.

Balancing double seated poppet valves is not so difficult a matter as it is with the single valve, since

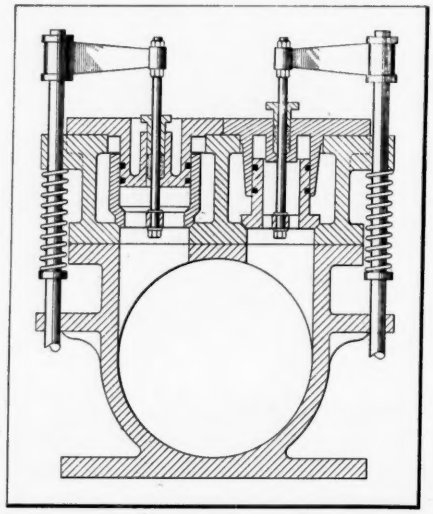


FIG. 10. SINGLE SEATED BALANCED POPPET VALVES

the former has 2 disks placed on the same valve stem with boiler pressure acting above the upper and below the lower while the cylinder pressure is between the disks. The upper disk is the larger in diameter, which forces the valve firmly to its seat and also permits more ready access to the lower valve disk. A good example of this type is the Putnam valve shown in Fig. 11. These engines are operated by cams in such a manner as to give a variable cutoff position.

Arrangement of Valves

THE type of valve used limits considerably the arrangement upon the cylinder, thus with the D valve or any single valve it is customary to place the valve on the side of the cylinder; this is largely a matter of convenience but also is of advantage in taking moisture from the cylinder.

On 4-valve engines the usual arrangement of valves is to place the steam valves above and the exhaust below the ends of the cylinder, this arrangement is most convenient from a mechanical standpoint and insures that the cylinder is always well drained.

Length of Ports

THE great bugaboo of a steam engine is cylinder condensation. It takes place, to a certain extent, in all engines, yet to ascertain the exact amount is almost impossible. We know, however, that it does take place, and to eliminate it as far as possible is the aim of every engine designer. It is recognized that the shorter the steam port the less will be the initial condensation, other things being equal.

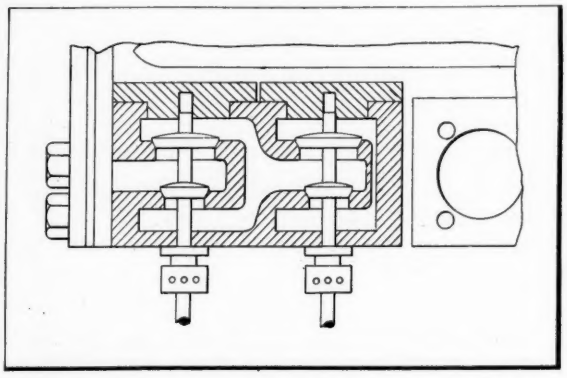


FIG. 11. DOUBLE SEATED PUTNAM POPPET VALVES

Not only do long ports increase initial condensation, but also the clearance. It is therefore of considerable importance that the steam and exhaust ports be as short and direct as possible. The 4-valve engines offer the best opportunity for short ports of any of the valves that have been designed as yet, since each one is operated independently of the others, and may be placed in the most desirable position.

Balancing of Valves

CONSIDERING pressure at 100 lb. and a plain D valve 4 by 8 in., it is evident that the eccentric must push a load of 3200 lb. or with a coefficient of friction of 0.2 the exact pull and push on the rod is 640 lb., which climbs up into horsepower pretty fast, as the speed and travel of the valve are increased. The need of reducing friction then becomes evident, and the common method is by balancing.

Flat valves commonly employ what is called a balancing plate, as shown in Fig. 1, with steam spaces opposite the ports in the steam chest, the plate being held away from the valve seat the thickness of the main valve plus about 0.002 in. to make a good bearing. This arrangement takes the pressure off the moving parts.

A partial balancing is obtained by admitting the steam from the center of the valve and exhausting from the ends, the valve being held to its seat by the pressure of a spring.

Another method employed for balancing slide valves is to fit them with balance rings which slide against the steam chest cover. This type of valve will telescope and automatically take up wear, yet the ring is free to revolve, changing position with every stroke of the valve, preventing creasing or cutting of the seat. By this means 80 per cent of the area of the valve is relieved of pressure, which leaves sufficient pressure to maintain a steam tight valve under all operating conditions.

In piston and cylindrical valves the only unbalancing effect is due to the area of the valve rod as it passes through the stuffingbox, which is eliminated in the case of the valve with inside steam edges, and may be balanced by extending the rod through a stuffingbox at the other side of the steam chamber, though this is seldom done and is hardly necessary.

SPECIAL VALVES

FROM the discussion of the plain D valve, driven by the plain eccentric it is evident that much is left to be desired in the way of quick opening, quick closing, early cutoff, and ability to vary the cutoff. The 2 most common methods of accomplishing these results are the use of the rotary valve, and some form of link motion, frequently a toggle joint. The most common type of the rotary valve is the Corliss which has already been discussed in connection with the D valve, and which is made single ported in the smaller sizes and for the larger sizes double ported in order to get quick opening with short valve travel. In the positively driven Corliss valve motion, it is common practice to use a compound toggle joint in order to get quick opening and closing and a long dwell both when open and when closed. The arrangement of such drive is discussed in the special section devoted to types of Corliss valves and valve gears.

In some cases the link motion and the toggle joint action are adopted with reciprocating valves in order to get quick opening and closing, but the link drive is especially adapted to a rotating or oscillating valve such as the Corliss type.

Clearance and Drainage

IN studying the D valve, if it is made just long enough to accomplish the admission and outlet of steam from the cylinder it will be seen that it is necessary to have long ports leading from the valve seat to the ends of the cylinder. This is objectionable for 2 reasons: In the first place it gives long passages which must be filled with steam at each stroke of the engine, wasting steam. In the second place it gives a large amount of surface which is chilled by the exhaust steam and must be warmed by the incoming steam, thus increasing the condensation of steam during admission.

This condensation is bad in 2 ways, it cuts down the efficiency of the engine and also increases the difficult problem of keeping the cylinder free from water. If the valve is located on top or at one side, either the water must be drained out through special drain cocks at the bottom of the cylinder or it must be carried out by the current of steam through the exhaust outlet. In the one case of drain cocks there is sure to be more or less waste of steam along with the draining of the water, and in the case of depending upon the current of steam to sweep the moisture out of the cylinder, there is always danger that the current may not be operative and an accumulation of water in the cylinder may cause trouble.

To get rid of these long ports and also to facilitate the matter of drainage, it is found desirable to use

separate valves at each end of the cylinder, and frequently to use 4 valves, 2 located on top or at the side for admitting steam and 2 others located at the bottom for exhausting steam. In this way the valves can be set close to the cylinder walls, thus cutting down the clearance and the port surface; also with the exhaust valves placed at the bottom of the cylinder, the condensation and moisture brought in with the steam will naturally drain out through the exhaust ports at each stroke of the engine.

Another advantage of the oscillating valve over the reciprocating is that in the reciprocating valve driven by an eccentric, it is slow in opening and closing, and must overtravel in order to get the entire port opened for more than an instant. Also the center of gravity of the mass must move as far as the acting surface, which increases the inertia of the valve and requires more force to stop and start it. In the rotary valve with a heavy body and a light weight at the acting surface, the center of gravity may be near the center of motion, therefore the inertia will be greatly reduced. Also from the nature of the rotary motion the toggle joint can be more compact. Examples of the rotary motion with the toggle joint are the ordinary Corliss valve gear with wristplate and links, also the positive drive Corliss such as the Ball and the Ridgway en-

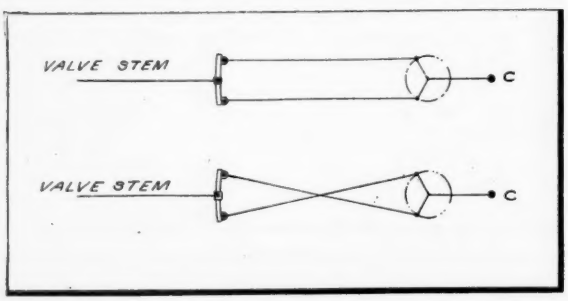


FIG. 1. OPEN AND CROSSED RODS FOR STEPHENSON LINK

gines. Examples of the reciprocating 4-valve engines are the Porter-Allen, the Buckeye, and the Fitchburg.

In the effort to cut down the port length, the valve may be made long, thus bringing the acting ends of the valve near the ends of the cylinder, but in this case the size of the valve is greatly increased and the area underneath the valve, which is subject to exhaust pressure on the under side and to steam pressure on the upper side, is thereby greatly augmented. This increases the friction of the valve and the power required to move it. It becomes desirable therefore in such designs to arrange valves so that there shall be the same pressure on both sides, thus making it balanced as is the case of the piston valve. The most common example of this is the Sweet valve with balancing plates, which is made with openings through the valve so that there is the same pressure on both sides, and the pressure on the back of the balancing plates is born by side strips which carry the weight of plates and of steam pressure.

Methods of Driving the Valve

ACTION of the common eccentric has been explained in the discussion of the D valve, and when the eccentric rod is long, this is practically the same as the action of the Scotch yoke in which the horizontal motion of the valve is exactly the same as the horizontal motion of the eccentric. The crank on the end of the shaft, used in place of the eccentric gives of course the same effect as the eccentric.

From the study of the D valve, it is evident that the limits of cutoff with a single eccentric are quite small, and if a variable cutoff is to be used it becomes necessary to use some form of trip mechanism or to vary the eccentric action by means of the governor. Separate eccentrics may be used for the steam and exhaust valves, and the steam eccentric be put under control of the governor, in which case the steam eccentric may be swung to any desired position in order to give long range of cutoff.

In the case of a disconnecting gear, which governs the cutoff by governing the trip mechanism, the cutoff becomes entirely independent of the eccentrc adjustment.

Of course, by the introduction of rockers and links, it is possible to change the eccentric motion so that we may bring the cutoff at any desired point, as for

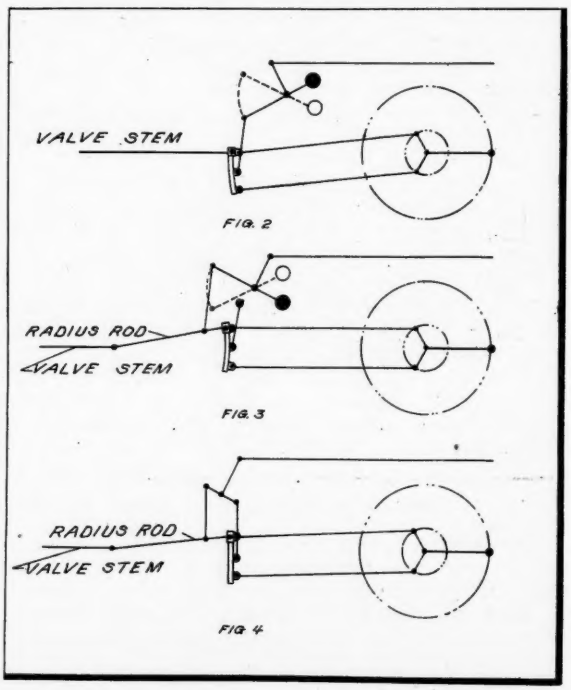


FIG. 2. SKELETON OF THE STEPHENSON LINK MOTION
FIG. 3. ARRANGEMENT OF LEVERS OF GOOCH LINK
FIG. 4. ALLEN LINK MOTION

instance in the case of the Porter-Allen engine, the steam valves are driven through a rocker link motion and the connection of the valve rod to the link is varied to give longer or shorter valve travel.

It is also possible by using a cam drive, such as is used on the Putnam engine, to give the valve any motion desired in opening and closing. The tendency at the present time is to get as high piston speed as possible, which involves the use of positive drive for the valves.

Reversing Motions

REFERRING again to the study of the D valve action, it is evident that in order to reverse an engine it is necessary to change the location of eccentric with respect to the crank by an angle of 180 deg. less twice the angle of advance. This could be accomplished by having the eccentric loose on the shaft and controlled by a lever, but ordinarily it is more easily accomplished by the use of 2 eccentrics, one set for forward running and the other for backward running. Then have a

link motion by which the valves may be placed under control of either one or the other eccentric according to the direction in which it is desired to run.

All link motions are based on this principle; in the Stephenson link, the eccentrics are attached to the ends of a curved link and this link is moved to bring either one eccentric rod or the other into action on the link block, which drives the valve rod. It is evident that if this link block is half way between the eccentric rods the valve will get little motion and the engine will not operate, also as the link is moved from center to bring the link block under the control of one eccentric or the other, the valve will get an increasing amount of motion so that the valve travel may be carried from O to the maximum possible, and the cutoff can be thus controlled.

In the Gooch link, the link is held stationary and the end of the valve stem, called the radius rod, is moved up or down in the link so that the valve will be driven by one or the other eccentric as desired. In the Allen motion, which is largely used on locomotives, the link is straight and both link and block are moved, the link rising as the radius rod falls.

One statement made above must be modified in that if the rods are arranged "open," Fig. 1, that is, if they stand practically without crossing when both eccentrics are pointing toward the link, the lead increases as the valve stem comes toward the center of the link so that port opening never becomes zero and the engine cannot be stopped by setting the link motion at mid gear. If, on the other hand, the motion is what is known as a "crossed rod motion," the lead decreases as the valve approaches mid gear and the engine can be stopped by setting the link at mid gear, even with the throttle wide open.

EFFECT OF ANGULARITY ON D VALVE

By C. R. McGahey

STARTING with Fig. 1, which is accurately laid out, the crank i. e., the bulge of our eccentric is at position 1, as shown, the connecting rod reaching from 1, on the circular path E to position 1 on the line MN which is the line of travel of the valve. As we have taken this as our starting point in moving in the direction indicated by the arrow on circle E, when we move to the point 4 on the circle E we find the rear of the connecting rod at 4 on the line MN, and as we carry our crank or eccentric around to 2 on circle E, the crosshead position is then 2 or 1 on the line MN. Carrying the eccentric on around to position 3, the connecting rod end will be at 3 on line MN.

By measurement the lines from 1 to 1, 4 to 4, 2 to 2 and 3 to 3 are the same, as the connecting points of the connecting rod on any engine are always fixed, so is this distance. But the distance on line MN from 2 to 3 is less than that from 2 to 4.

As the travel of the valve is uneven, the outside or steam edges on a common D valve are set so as to give the same lead at each end of the cylinder, and the valve is made with equal cutoff edges, that is the distance C, Fig. 2, on each end of the valve is equal and when the valve has been set as outlined, having an equal lead, our cutoff will be unequal.

From Fig. 1, you can see that the valve must necessarily move more rapidly from 1 to 4 and 4 to 2 than it does from 2 to 3 and 3 to 1; this will show up clearly on an indicator card, the admission and cutoff will be much more sluggish at one end than at the other. As can be seen from Fig. 2 the eccentric makes the same movement as explained in Fig. 1 and the valve takes the same relative positions on the line MN so it is quite evident from this that a gear thus designed will have more travel during one half the revolution of the eccentric than during the other, and if the ends of the valve have the same proportions the cutoff and exhaust will be affected.

Should a valve be made as some are for such a gear having the one end longer than the other, as shown in the valve in Fig. 2, this tends to eliminate the error. It is impossible to have equal cutoff and lead with one of these gears. The closer the valve is to the center of the shaft the more pointed will this error be; on engines with long eccentric rods the error will be very slight. This error has been corrected in the ordinary valve gear by imposing an inclined rocker in the valve gear and the error due to the angularity of the connecting rod can be almost eliminated.

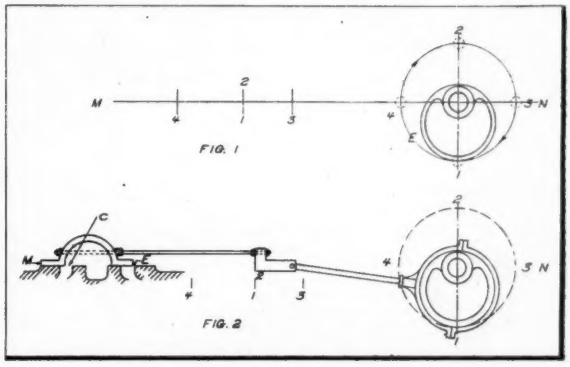


FIG. 1. DIAGRAM OF ECCENTRIC AND CROSSHEAD POSITIONS
FIG. 2. D VALVE DESIGNED TO OVERCOME ANGULARITY OF ECCENTRIC ROD

Some engine designers make use of the rocker arm and eccentric rod guide to help eliminate the error in the gear and some make the valve with one end longer than the other, as shown in Fig. 2, but many of the ordinary slide valve engines are made with no effort to remove this slight difference, as there has been no test or evidence to the effect of any saving gained by having the cutoff equal on such an engine.

SPEAKING OF THE care of machinery—who was?—the method of the German farmer as told by an agent of the International Harvester Co., may seem a little over particular, but we suspect that his machines are always ready to carry the "peak of the load."

"The German's care of his machines is exemplary. As most of us took care of our first bicycle, so does the German care for his mower, reaper, engine, or whatever it may be. Usually the machine is oiled till it gasps for breath, then it is oiled some more. After cutting, the knives are removed and washed, the cutter-bar also gets a bath, as does the rest of the machine, if by chance it be muddy or dusty. Then the machine is carefully oiled again, and placed under a shed or in the barn, and there it remains till the next season. The German farmer can therefore use a machine for many years, where many American farmers have already put several in the scrap-heap."

The same kind of loving care is good for power plant machinery.

CORLISS ENGINE PRACTICE

A BRIEF DISCUSSION OF THE VARIOUS TYPES

CORLISS engines, although made in several forms, involve the same general principles, and may be classified in several different ways. There are the horizontal and vertical, single eccentric and double eccentric, box frame and girder frame, release gear and positive gear types. The release gear type is made in several styles, but all embody the same general principles, and may be divided into 2 general classes, those that open the valve outwardly, and those that open the valve inwardly.

In a single eccentric release gear type of engine, all 4 of the valves are operated by one eccentric, and the cutoff occurs only when the wristplate is moving in one direction. The valve must be closed before the motion of the wristplate reverses or the cutoff will be near the end of the stroke.

Steam valves are given lap, and the eccentric angular advance on account of the exhaust. If the exhaust valve had no lap, release and compression would occur at the end of the stroke instead of before the end, as it should to obtain good distribution.

Since the exhaust valves must have lap and there is but one eccentric, the steam valves must also have lap, as will be explained later. Figure 1 shows a side elevation of a common type of release gear Corliss engine. The essential parts are the release gear for the admission valves, the wristplate, the valve stems, the cranks for operating the exhaust valves, and the dash pots. The valve stems can be lengthened or shortened, as the case may require, and the action of any one valve regulated independently of the other 3 valves.

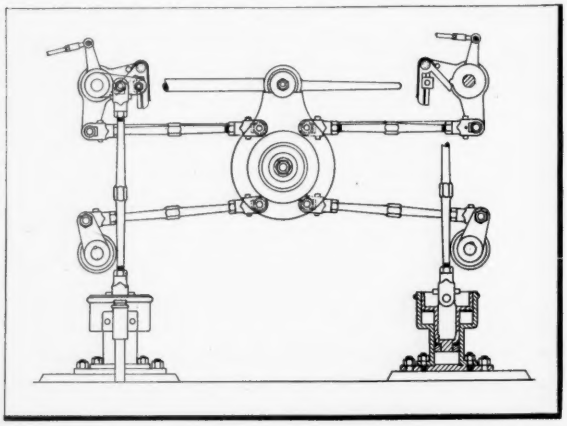


FIG. 1. SIDE ELEVATION OF A RELEASE VALVE ENGINE CYLINDER SHOWING VALVE GEARING

The advantage of this type of valve gear is that it permits an earlier cutoff with a greater range, a more perfect steam distribution and a smaller clearance space than is obtained by a plain slide valve.

A sectional view of the cylinder is shown in Fig. 2. It will be seen that there are 4 separate and distinct valves. Two of these, V and V^1, connect directly with the steam chest D, and are called the steam valves. The other two valves, R and R^1, connect directly to the exhaust chest L, and are called exhaust valves. All of the valves are cylindrical in form and extend across the cylinder above and below respectively.

Characteristics of the Single Eccentric Engine

IT has already been stated that the peculiarity of the Corliss valve gear is the limitation of the point of cutoff with a valve operated by a single eccentric. In Fig. 3, the left hand steam valve has opened the ports to the amount of the lead, and it will be noted that the eccentric has moved away from the vertical position a distance equal to the angular advance A. This movement of the eccentric is necessary in order to move the valve through the distance corresponding to its lap and lead. A certain amount of lap must be used on both steam and exhaust valves in order to make them steam tight.

In Fig. 4 the steam valve has opened the port wide, and the eccentric has reached its extreme point of travel. The valve must, therefore, be released and the position of the piston indicates the point of cutoff, which is approximately half stroke. The next event in the stroke is the exhaust closure or point of compression, which is illustrated in Fig. 5.

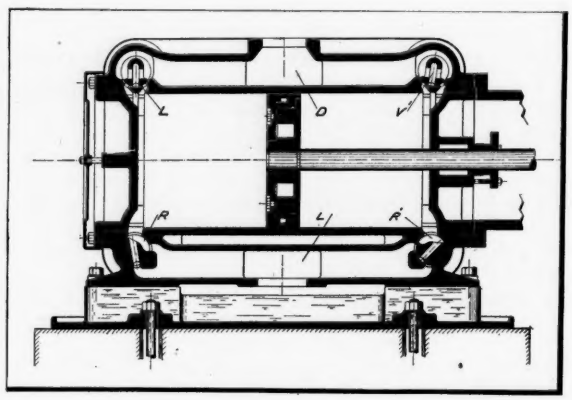


FIG. 2. SECTION THROUGH A CORLISS ENGINE CYLINDER SHOWING LOCATION OF VALVES

It will be seen that if the angular advance of the eccentric had been less causing the steam valve to remain open longer than the stroke, the exhaust valve would not yet have been closed, thereby destroying the compression. Again, if the exhaust valve in Fig. 4 were adjusted to close earlier by means of the radial rod to the wristplate it would not give full opening with the same travel of the valve, and would increase the back pressure on the engine. Thus it can be seen that with one eccentric, cutoff must be limited to a certain point, otherwise it will interfere seriously with the operation of the exhaust valve.

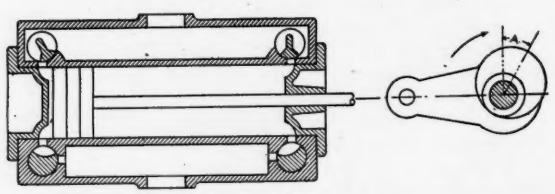


FIG. 3. POSITION OF ECCENTRIC WITH VALVES OPEN TO THE AMOUNT OF THE LEAD

The Double Eccentric Engine

IN the double eccentric type of engine the release valve is operated by one eccentric and the exhaust valve by another eccentric. The principle of operation other than that involved in having separate eccentrics for the steam and exhaust valves is the same as that of the single eccentric engine. The advantages

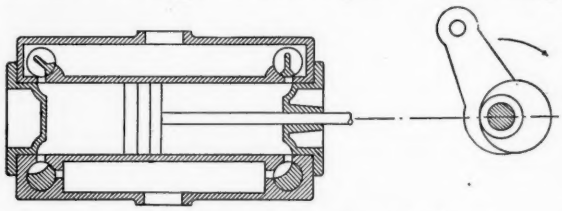


FIG. 4. EXTREME POSITION OF ECCENTRIC

of using 2 eccentrics is that the steam valves and the exhaust valves may be set independent of each other.

Figure 6 shows a side elevation of the gear side of a double eccentric engine. It will be noted that

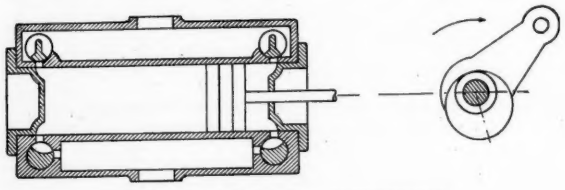


FIG. 5. POINT OF COMPRESSION

there are two wristplates oscillating on one stem but operating independently. Each wristplate is actuated by a separate catch rod through the eccentric rod connected to the eccentrics.

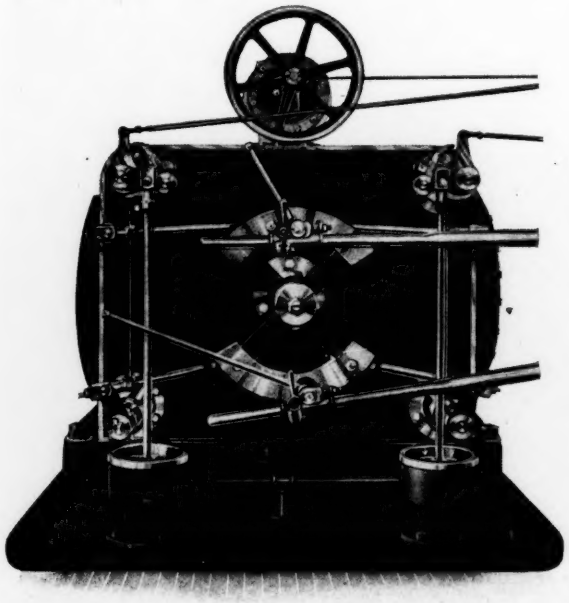


FIG. 6. TYPE OF DOUBLE ECCENTRIC RELEASE VALVE GEAR WITH TWO WRISTPLATES

The Positive Gear Type of Engine

IN the positive gear type of engine, the valves are similar to those of the releasing gear type, a variable cutoff being effected by the variable closing of the admission valves. These valves are directly under control of the governor, which is of the shaft or wheel type, operating a movable eccentric, while the exhaust valves are actuated by a separate eccentric having a fixed position on the main shaft. The positive type of gear was developed to meet the demand for a higher

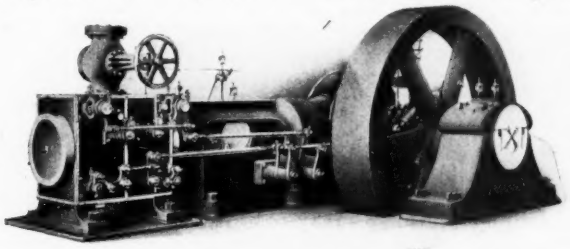


FIG. 7. TYPE OF POSITIVE GEAR CORLISS ENGINE WITHOUT WRISTPLATES

speed engine than would come within the limitations of the release gear type which is limited to somewhat under 100 r.p.m. The positive gear type of engine may be constructed with or without wristplates. Figure 7 shows a positive gear engine without wristplates. It has a double eccentric, two eccentric rods and two catch rods in every respect similar to those of a double eccentric release gear type of engine.

Valves and Releasing Gears

FIGURE 8 is a diagram showing the relation of the valve opening to the stroke of the engine. In the figure, A refers to a double ported valve and B refers to a single ported valve. The difference in speed in opening and closing a double and single ported valve

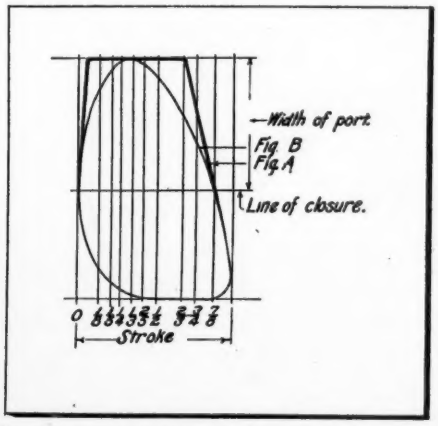


FIG. 8. DIAGRAM SHOWING RELATIVE ECONOMY OF A SINGLE- AND A DOUBLE-PORTED ADMISSION VALVE

is shown by the fact that A is wide open before ⅛ stroke, while B is not fully opened until after ¼ stroke. For both valves to be closed at ⅞ stroke, B must begin to close almost as soon as it is open, while A need not begin until ⅔ stroke. The net gain represented by the use of double ported valves is equal to the difference in areas inclosed by A and B.

Wire drawing with its bad effect, owing to the slow opening and closing of single ported valves, is also shown by B.

A double ported valve has many points of merit other than rapid operation, which are peculiarly its own, among which may be mentioned the even distribution of metal which provides against its warping, due to expansion from the heat of the steam or uneven wearing of the seat.

There are 4 general types of release valves gearing: those that open the valve outwardly, those that open the valley inwardly; the push type and the long cutoff type.

Figure 9 shows a gear for opening the valve outwardly. The lettering will show the readers plainly the essential features. In this particular style the knockoff lever is fitted with double cams for use with an automatic safety stop motion.

Figure 10 shows respectively the front elevation, plan and rear elevation of the inward opening type of valve gear. In all of the views A represents the valve-stem and B the valve lever which is secured to end of valve stem by feather and set screw. CC^1 is a double crank vibrating loosely on a projection of the bonnet which supports the valve stem and this double crank is connected by an adjustable link rod X to the wristplate from which it receives its motion. The end of the arm C carries a small rocker shaft D, which has a hook E fastened on the end. This hook is provided with a hardened steel catch plate, which engaging a similar plate c, fastens on the valve-lever B, and the hook is kept in place by a light spring.

On the end of the rocker shaft D, opposite the hook E is fixed a lever F, having a pin h, on which is mounted a friction roller R^1. A triple lever H, H^1, H^{11}, oscillates upon a projection of the bonnet, which supports the valve stem. The arm H is connected by an adjustable rod Z to the governor. The arm H^1 has a pin j on which is mounted a friction roller R, and on the arm H^{11} is mounted an adjustable cam W, or friction roller which is used for the stop motion.

By referring to the rear elevation in which the double crank C C^1, is moved by the wristplate in the direction indicated by the arrow, it will be seen that all the parts which are connected to the double crank C C^1, will move around the center of valve-stem A; the side of friction roller R^1, nearest to the valve stem will describe an arc of a circle indicated in the figure by a broken line, and when it passes over roller R it will be pushed away from the center of valve stem A, thereby causing the small rocker shaft D to turn slightly, and at the same time to move the engaging point of hook E far enough to release the valve-lever B, when the dash pot will act and close the valve.

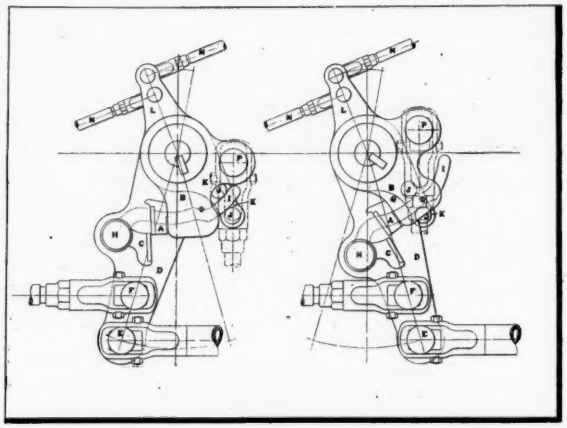
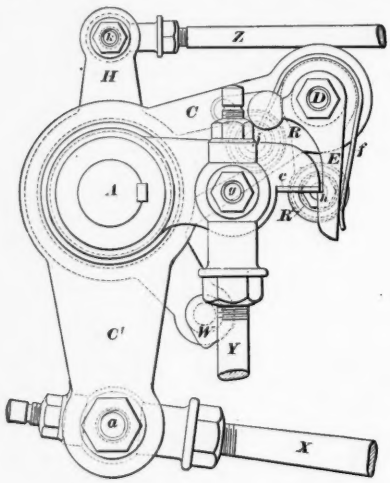
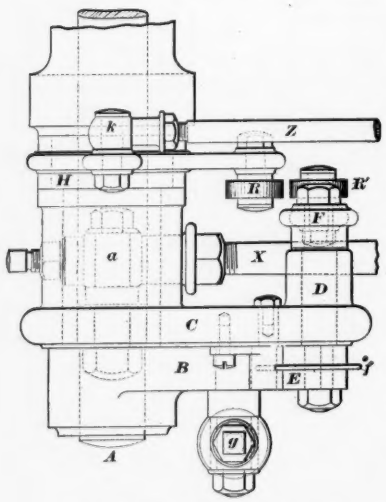


FIG. 11. EXTREME POSITIONS OF PUSHING TYPE RELEASE VALVE GEAR





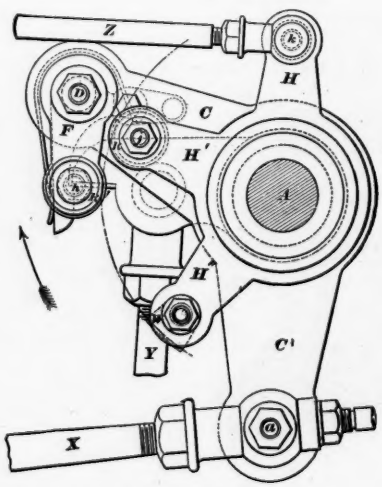


FIG. 10. RELEASE VALVE GEAR FOR OUTSIDE OPENING OF VALVE

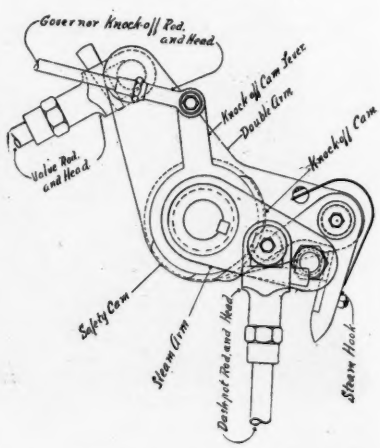


FIG. 9. RELEASE VALVE GEAR FOR INSIDE OPENING OF VALVE

At the moment of release the pressure on a triple lever, caused by the liberation will be exerted in a radial line from j to A; by the action of the friction rollers R and R^1, there will be no appreciable strain to turn the triple lever on its axis, and consequently

there will be no tendency to disturb the normal action of the governor. As the position of the triple lever is controlled by the governor, any variation in the height of the governor caused by change of load on engine will change the position of point j and of roller R, and so make variations in the time of release of steam valves and corresponding point of cutoff in steam supply to cylinder.

Figure 11 shows push gears with the front end of the cylinder in the extreme left and opening position. The latch A on the valve stem lever B is in the position of engagement with the toe C on the rocker D. The pin E connects through the intermediate rockers and rods with the stem eccentric on the engine shaft, and the pin F connects to a similar inlet gear at the back end of the cylinder. As the rocker D moves to the right the toe C engages the latch A, moving the inlet valve to open and raising the back rod plunger which is connected to the pin P.

Cutoff is accomplished by the toe C turning downward on its pivot spindle H to release the latch A. Spindle H has a cam lever I, rigidly attached to the rear, which in turn is carried between 2 hardened steel rolls J J. These rolls turn on pins in the cutoff collar K, which latter turns freely on the valve stem journal. The arm L above forming part of the same casting as the cutoff lever K, is connected to the governor by the rod M. This rod is held firmly by the governor and does not move unless there is a change in the speed of the engine. The rod N connects with the valve gear at the head end of the cylinder and the latch A is released at some point in the opening movement of the rocker D toward the right. This is accomplished when the rise O of the cam lever passes between the cam rolls J J.

It it obvious that the length of cutoff depends upon the position of the cutoff collar K as controlled by the governor. The further to the left the collar K, the earlier the cutoff.

The right hand view shows the rocker B at the extreme right position of its motion. Release has taken place and the valve is about to be closed by the pull in the dash pot. The valve then closes promptly and lever B turns to the position shown at the left. The cutoff collar K is here shown in the position giving nearly the latest cutoff, which is about ¾ stroke of the piston. On the return movement of the rocker D, the cam rolls J J, raise the cam lever I, and the toe C to the engaging position. At the latter part of the movement of the rocker D to the left, as the toe C passes under the latch A, the latter is raised by the toe sufficiently to clear it, and the latch there drops by gravity in front of the toe to the engaging position.

No reaction is brought on the governor in releasing the gear. It will be seen also that the latching is a positive one, cannot jump out, has no strain on toe and latch plate bolts during the release, and is independent of the use of springs. In engagement the pins are all protected from strain.

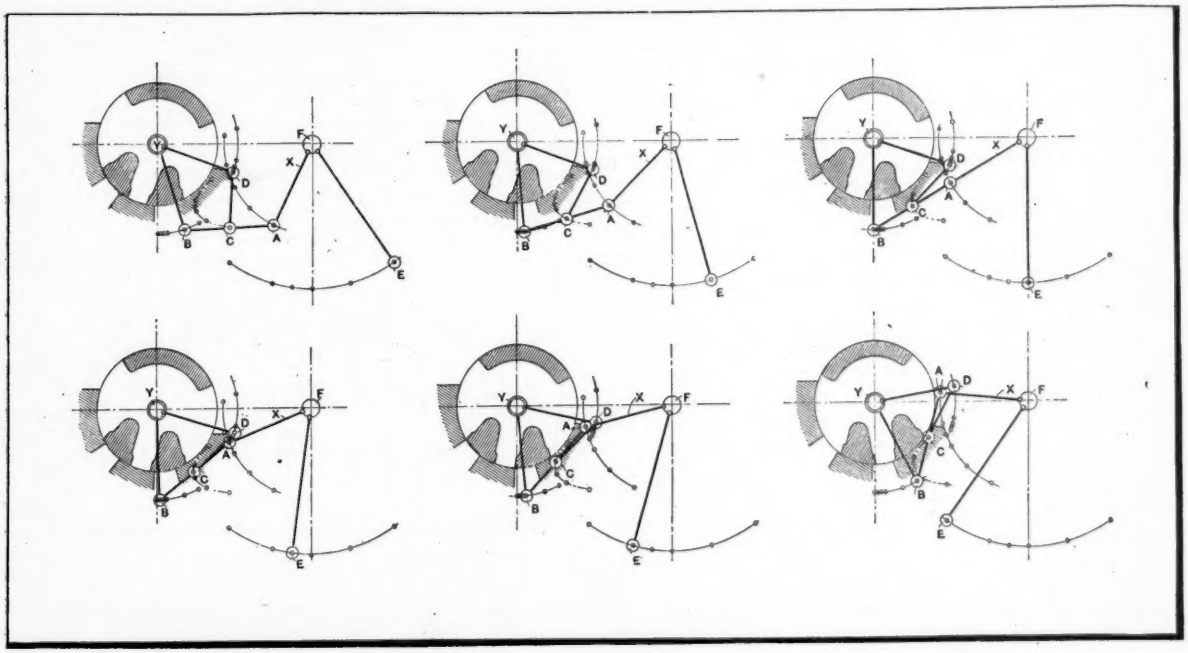


FIG. 12. GEARING OF A POSITIVE GEAR ENGINE PLOTTED IN AN ELEMENTARY MANNER

Figure 12 shows the valve gearing of a positive gear type of engine plotted in an elementary form. By following the motion of the parts from left to right, starting on the upper row it will be seen how the link C D connecting with the valve crank simply swings around the point D, without imparting any motion to the valve crank V D, for half of the total movement of the eccentric valve which describes it. The motion which this gear gives the valves is exceedingly smooth and easy. At the usual load the valves have their highest speed at the instant of opening.

BY REASON OF A GIFT of $60,000 by Florence O. R. Lang, to Sibley College, of Cornell University, a new building will be erected to accommodate the workshops, which will be 3 stories high, 170 ft. by 50 ft., and will be placed just east of the present mechanical laboratory. The present building used as a shop will then be available for the research work conducted in the New Research Department by Prof. R. C. Carpenter, which carries on special researches, the results of which are published in the Sibley College Journal of Engineering.

STEAM ENGINE GOVERNORS

By C. F. Swingle

GOVERNORS ARE USUALLY classified under 2 general heads or divisions: First, the throttling governor by means of which the supply of steam is throttled in the steam pipe, the result being that the steam pressure in the valve chest is more or less reduced below boiler pressure; second, cutoff governors which act to vary the admission of steam to the cylinder while at the same time boiler pressure is maintained in the valve chest.

Throttling Governors

ALTHOUGH this method of regulating the speed of engines is old and has many disadvantages connected with it, nevertheless it possesses a few advantages, as for instance: The valve gear of the engine may be very simple and inexpensive; 2, there will be less inequality in the steam effort at the beginning and end of the stroke; 3, the effect of driving the steam through the throttling orifice of the governor tends towards a partial superheating of the steam, owing to the pressure on the boiler side of the valve being greater than that on the cylinder side; 4, owing to reasons 2 and 3, there is likely to be small cylinder condensation with a throttling governor.

Disadvantages of the throttling type of governor are: 1, it is not sensitive to instantaneous changes of resistance to the speed of the engine, for the reason that control of throttling can only take effect in the cylinder at an interval after the governor has acted to throttle the steam, or to open the valve wider; and during this interval the piston may make one or more strokes under the conditions of load and pressure which prevailed before the governor acted. For this reason the throttling governor does not, and cannot regulate so close to uniform speed as does the automatic cutoff governor; 2, the exhaust, or terminal pressure in the throttling engine is higher than it is with an automatic cutoff engine working under the same conditions as to boiler pressure and load, thus exhausting more heat from the cylinder than when by an early cutoff, and high expansion the heat energy is more completely converted into useful work.

Cutoff Governors

AMONG the many advantages gained by the use of the cutoff governor may be mentioned: 1, Extreme sensitiveness, due to the fact that just enough steam is admitted to the cylinder at each stroke of the piston to do the work of that stroke required by the variation of resistance; 2, the governor operates immediately to control the admission for the next stroke; 3, full pressure is exerted against the piston at the beginning of each stroke, and up to the point of cutoff, which depends for its location, upon the resistance; 4, a much lower terminal pressure, thereby gaining the economic advantage of having as great a difference between the initial and terminal pressures in the cylinder as is consistent with doing the foot pounds of work required for that particular stroke.

Disadvantages of the cutoff governor, as compared with the throttling type, are hardly worth enumerating, although there are a few; such for instance as a more complicated valve gear, an increased amount of cylinder condensation, resulting as before stated from the wide difference between the initial and terminal pressures with an early cutoff. The balance, however, is largely in favor of the automatic cutoff governor.

Governors should also be classified according to the arrangement of their mechanism; as for instance, the flyball, or pendulum governor, which revolves on a vertical axis, or spindle; and the shaft governor, which revolves in a vertical plane with the crank shaft of the engine as the axis.

Shaft governors require no connecting mechanism between the engine shaft and the governor, while flyball governors must receive their motion from the engine shaft through the medium of either a belt and pulleys, or a side shaft and gear wheels.

Flyball Governors

FIGURE 1 shows typical arrangements of the flyball or pendulum governor. As the speed of the shaft increases, centrifugal force causes the balls to move farther and father from the spindle. The change in the position of the balls is utilized to operate the mechanism which either varies the point of cutoff, or throttles the flow of steam in the steam pipe.

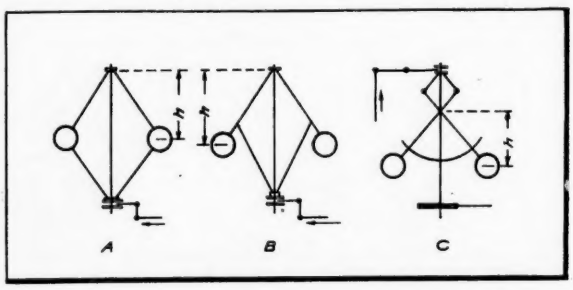


FIG. I. TYPES OF FLYBALL GOVERNORS

The first plan, A, produces the greatest change for a given change in the position of the balls. The other plans usually give greater leverage on the controlling mechanism, thus making light balls more effective.

The time of a revolution multiplied by the velocity is equal to the diameter of the circle in which the balls revolve, and the time is equal to 1.106 times the square root of the height of the cone of revolution, h. In other words, h, or the height of the plane of the balls below the point of the cone of revolution, varies inversely as the square of the number of revolutions per minute.

From these facts, it is apparent that there is a height, h, for every speed, and that the balls will be at their highest point, at the highest permissible speed. This is true of all flyball governors, and in the case of a throttling engine the valve operated by the governor should be tightly closed when the balls are at their maximum height; or if the governor is to regulate the speed of an automatic cutoff engine, such, for instance, as the Corliss type, the releasing mechanism should be so adjusted as to prevent any opening whatever of the admission valves when the governor balls are at their highest position.

In the adjustment of a flyball governor for this type of engine, the first point should be to adjust the lengths of the horizontal rods connecting the governor with the releasing mechanism, so that the steam valves

will cutoff at points equidistant from each end of the stroke. This is done by raising the hook rod clear of the wristplate pin, and with the bar provided for the purpose move the wristplate to either one of its extreme positions, as indicated by the marks on the hub. Then hold it in this position, the governor balls being at their lowest position, and adjust the length of the governor rod for the steam valve at that end of the cylinder (the valve being wide open) so that the boss, or roller which trips the releasing mechanism, is just in contact, or within 1/32 in. of it.

Next move the wristplate to the other extreme of its travel and adjust the length of the other rod in the same manner. To prove the accuracy of the adjustment, raise the governor balls to their medium position, or about where they would be when the engine is running at its normal speed, and block them there.

Then, having again connected the hook rod to the wristplate, turn the engine in the direction in which it is to run, and when the admission valve is released, measure the distance upon the guide that the crosshead has traveled from the end of the stroke. Now continue to turn the engine in the same direction until the other valve is released, measure the distance that the crosshead has traveled from the opposite end of the stroke, and if these 2 distances are the same, the cutoff is equalized. If there is difference, lengthen one rod and shorten the other until the point of cutoff is the same for both ends.

Changing the Speed of an Engine

THERE are 2 ways in which this can be done with an engine equipped with a flyball governor: First, by changing the diameter of the governor pulley; or, if the governor is operated by a small countershaft and bevel gear, changing the diameter of the gear wheels. Second, by adding weight either to the counterpoise, if the governor is of the loaded type, such as the Porter-Allen, or the balls might be replaced by heavier ones.

In case the change is made in the diameter of the governor pulley, the following simple calculation will show how the required diameter of the pulley can be ascertained, assuming that the speed of the engine is 75 r.p.m., and that it is desired to increase the speed to 85 r.p.m., without changing the speed of the governor, or interfering with the normal point of cutoff.

First find speed of governor; assuming the diameter of the governor pulley to be 9 in., and the driving pulley on engine shaft to be 12 in.; then $75\times12\div9=100$ r.p.m. for the governor; next in order to preserve this speed under new conditions, $85\times12\div100=10.2$ in. =new diameter of governor pulley. The same method of calculation can be used if it is desired to decrease the speed of the engine.

In case the governor is driven by a countershaft and gear wheels, the necessary change can be made without interfering with the speed of this shaft, by simply changing the dimensions of 2 gear wheels, the one on the governor spindle, and the one on the end of the countershaft, which meshes with it. For instance, assume the countershaft to be making 50 r.p.m. and that the bevel gear wheel on the governor end has 60 teeth, while the one on the governor spindle has 30 teeth; then the speed of the governor will=$60\times50\div30=100$ r.p.m. and, if the speed of the engine is increased 10 r.p.m. while the governor speed is to remain the same as before, the required number of teeth in the new governor wheel will be $60\times60\div100=36$ teeth.

Shaft Governors

THE shaft governor must necessarily be a cutoff governor. It turns at the speed of the engine, and is chiefly valuable at high rotative speeds, although in some recent designs, shaft governors have been geared from the main engine shaft so as to be run at a different speed. Shaft governors possess the advantage of being able not only to receive impulses more directly from the motion of the engine shaft, but also to transmit instantly the result of those impulses to the valve, or valves that control the admission of steam to the cylinder. With a correctly designed shaft governor and valve gear, there should then be the minimum of variation in the speed of the engine. Two factors enter largely into the action of shaft governors; first, inertia; second, centrifugal force. Inertia shaft governors usually consist of a single bar pivoted at or near its center to an arm of the governor wheel, and so shaped that while its center of gravity falls not

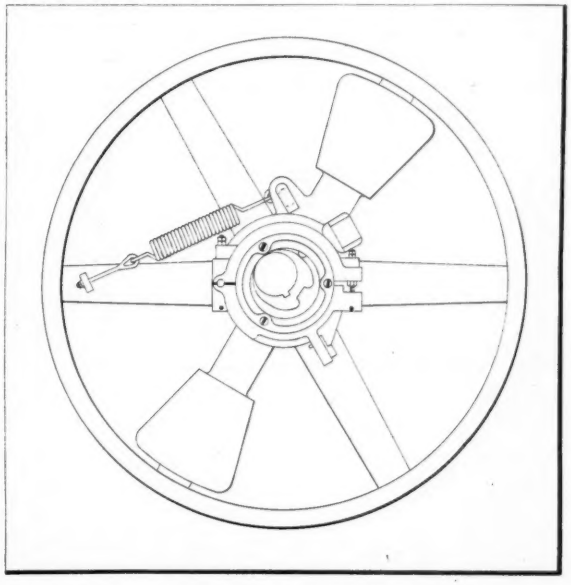


FIG. 2. THE RITES INERTIA GOVERNOR

far from the shaft center, the bulk of its mass is located at or near its 2 ends. As this bar rotates with the shaft, its inertia tends to keep it rotating at a uniform speed. For instance, if the speed of the shaft slackens, the inertia of the governor arm causes it to run ahead of the shaft; or, if the engine increases its speed, inertia tends to retard the governor arm.

The inertia bar also carries at its center the eccentric, or in some types of engines, a short arm extending from the inertia bar carries the eccentric pin which gives reciprocating motion to the parts that actuate the valve rod.

Midway between one end of the inertia bar and the bearing upon which it is pivoted, a heavy coil spring is attached to the bar and to the rim of the governor wheel. The object of this spring is to counteract the tendency of this end of the inertia bar which has the heavier weight, to move backwards after the engine has attained the desired speed. Figure 2 shows the Rites inertia governor. The eccentric is a plain finished ring, removable from the bar, and attached thereto by 3 countersunk screws. There is but one bearing in this governor that offers frictional surface, with the exception of the eccentric and its strap, and

this is the pivotal support for the inertia bar, consisting of a steel pin of large diameter that has a bearing in the enlarged portion of the pulley hub, as illustrated in Fig. 3. A hard bronze bushing enters the hub with a close turning fit, and this forms the bearing for the pin. The flanged head is milled to receive a spanner wrench, and a clamp bolt prevents the bushing from turning. The bearing is lubricated by means of 2 compression grease cups attached to the pulley hub with channels leading to the bearing.

In practice, the governor is keyed to the engine shaft so that the pin of the bar pivot is slightly ahead of the center line of the main crank. To prevent running over speed when without load, the valve

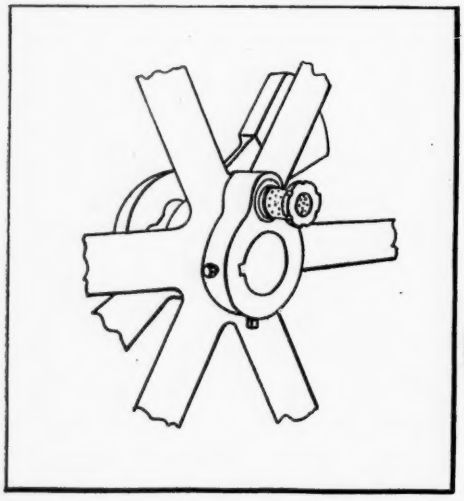


FIG. 3. DETAIL OF BUSHING FOR GOVERNOR BEARING

must have sufficient lap to give practically no opening when the inertia bar is in full speed position, and this also means no lead in this position. As the bar swings in, there is an increase in the amount of lead, but not sufficient to give enough lead in the usual running position unless the governor is set ahead, as described above. One disadvantage resulting from this is too much lead at the later points of cutoff.

The relative position of the parts is as shown in Fig. 3A, the pivot being placed nearly opposite the crank pin. The amount which it is set ahead of opposition to the crankpin is usually 10 to 15 deg. in order to arrange the governor so that its full-speed position will cut off steam entirely for no-load conditions, and will give a reasonably good lead for normal load.

With a single arm it is apparent that the governor is unbalanced statically and will tend to fall forward during half of the revolution and backward during the other half. If the speed is high, say over 250 revolutions, this effect is not material, but for lower speeds it will effect the cutoff, making it unequal at the 2 ends of the cylinder if steam is taken on the inside edges of the valve, and if steam is taken on the outside edges of the valve, equalizing the cutoff. If the speed is reduced much below 200 r.p.m., this unbalancing effect becomes noticeable as a jerk in the governor action, which may send the governor arm through its whole length of motion every second or third revolution.

To prevent this action a guide or brake spring is put on the flywheel rim to act on the end of the weight arm just enough to prevent sudden swinging, but not sufficient to interfere with the change of govrnor position when the speed of the engine changes. If the jerk is shown only by bumping on the stops when shutting down, the drag spring may be arranged so as to act on the arm only at its full load position.

One brake effect which is desirable in the inertia governor is friction on the large pivot pin, which is also in line with good mechanical design, as a heavy arm needs a large pin to carry it successfully.

For very low speeds, it is usually better to balance the gravity effect by introducing a separate weight and arm linked with the regular inertia arm and arranged so that the 2 arms balance each other as far as the gravity is concerned. This makes a complicated governor but one which can run at slow speeds and give the same sensitiveness of control as does the unbalanced governor at higher speeds.

If the governor is so arranged that the center of gravity is too near the shaft center, it will run over speed at starting and then drop suddenly when the governor begins to act. This is remedied by adding weights to the heavier end, or cutting away the lighter end to bring the center of gravity farther from the center of the shaft. Increasing the friction of the valve or

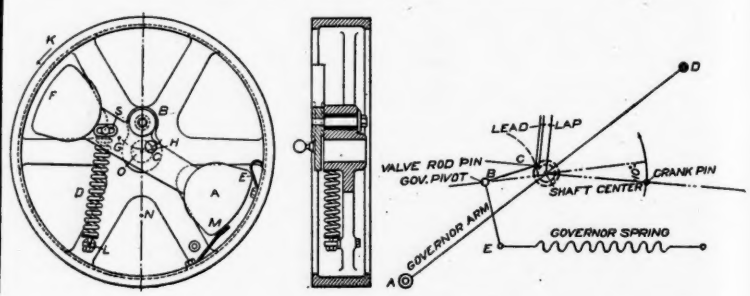


FIG. 3A. RELATIVE POSITION OF PARTS IN THE INERTIA GOVERNOR

valve stem acts the same as increasing the spring tension and the screwing up of the valve stem packing may cause a quite noticeable increase in the speed of the engine.

Shaft Governor Adjustments

IN case the governor does not properly control the speed of the engine, adjustments may be made as follows: First test the speed with a light load, say one-fourth of the rated load. If the speed is steady under slight changes of this load, but too slow, tighten the spring; if the speed is too high, loosen the spring tension. If the spring cannot be tightened enough to increase the speed the desired number of revolutions, cut off one or more coils, or if on the other hand the

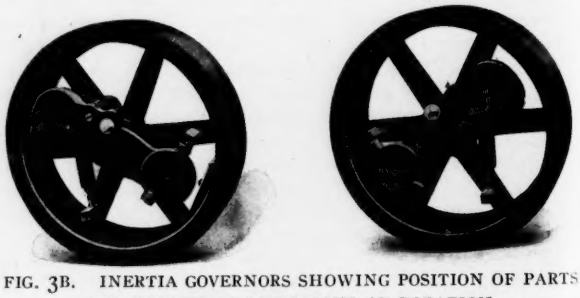


FIG. 3B. INERTIA GOVERNORS SHOWING POSITION OF PARTS FOR DIFFERENT DIRECTIONS OF ROTATION

spring is loosened to the limit, reduce the weight on the short end of the inertia bar. Second, having succeeded in getting good regulations with a light load, increase the load and, if the speed drops more than it should, move the spring pin toward the inertia bar

pivot along the slot provided for the purpose. If this does not effect the desired regulation, the weight on the short end of the inertia bar may be reduced still more, or the weight on the long end of the bar may be increased. The tension of the spring may also be decreased.

If the governor, under sudden changes of load, gives 2 or 3 long swings before steadying down, weights should be added to the long end of the arm on a line through the centers of the pivot and the shaft. This same remedy will apply if the speed changes too much at first and comes back too slowly after a change in the load.

Speeding up of the engine, as the load is thrown off, more than 2 per cent above the speed at moderate load is usually due to a leaky steam valve or insufficient steam lap, so that the valve does not cover the ports when the governor is clear out. The proper lubrication of the governor mechanism and the easy running of the valves should be carefully investigated when there is any difficulty with the operation of an inertia governor before any changes in weights or spring tensions are attempted.

Figure 3B shows 2 views of the inertia governor, one for under running and one for over running. If it is desired to change from one direction of rotation to the other, it can be accomplished comparatively easily. The arm of the wheel opposite the one supporting the weight arm, when the engine is running, has a suitable hole in it for the reception of the stud that supports the weight. On the rim of the wheel there will also be found another receptacle for the head of the spring.

To change the direction of rotation, first measure carefully the length of the spring, then remove the governor parts including the supporting stud. Insert the stud in the other hole and secure the head of the spring in the other pocket. Take up the spring by means of the nuts until its length is the same as before. This will reverse the rotation of the engine.

Irregularity of speed may be due to other causes than the governor; such as a hard working valve, insufficient lap, or the valve stem packing gland screwed up too tight. All of these matters should be carefully looked after before blaming the governor for irregular speed.

Fitchburg Shaft Governor

THIS governor shown in Fig. 4, acts mainly through the centrifugal force of 2 large weights, but it is also fitted with 2 smaller weights, the function of which is to balance the weight of the eccentric, thus causing the governor to be very sensitive and prompt in its action. The small weights, O, acting over generous pins D as fulcrums, balance the weight of the eccentric and its strap, and in vertical engines the valves and valve rods also, leaving no work upon the governor except to shift the eccentric when the load changes.

Connecting rod G is attached to the suspension arm C at E, acting directly upon the eccentric, while the opposite rod G^1 is attached to the opposite arm C at F. In this way the outward motion of both the centrifugal weights H, H^1 is exerted with equal power in moving the eccentric in one direction across the shaft. The action is as follows: So long as the engine is below speed, the eccentric is kept in its longest throw by the tension of the springs LL, and steam follows about ¾ of the stroke, but as soon as the proper speed is reached, centrifugal action causes the weights H, H, to overcome the tension of the springs and move outward, at the same time lengthening the springs. By means of the connecting rods G and G^1 the outward motion of the weights turns the suspension arms C, C, upon their fulcrums D, D, and through the ears B, E the eccentric is carried across the shaft. As the arcs described by the centers B, B, are in opposite curves they compensate each other, and the center of the eccentric follows a straight line in its movement, preserving a constant lead opening, or otherwise as desired.

This manifestly decreases the eccentricity, and increases the advance of the eccentric, giving an earlier cutoff, until when the eccentric is swung squarely back of the crank the valve opens only the lead, there being all points between this and extreme late cutoff for variation.

Upon the least diminution of speed, the springs have more power than the centrifugal force of the weights,

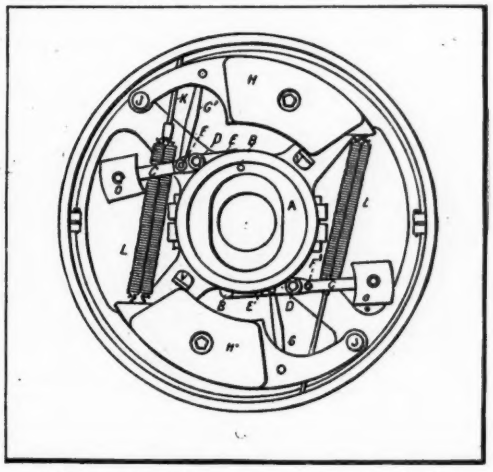


FIG. 4. GOVERNOR OF FITCHBURG ENGINE

and the motion of the parts is arrested, and turned in the opposite direction, giving a later cutoff as the load increases.

If it is desired to reverse the direction of motion of the engine it may be done by transferring the ends of the connecting rods G, G^1, from E^1 to F^1, and from F to E respectively. This will cause the outward motion of the weights H, H, to throw the eccentric in the opposite direction, and they are right for running the engine the other way, a new eccentric with opposite offset being substituted.

The principal changes for speed and sensitiveness are to be made on the springs. To increase the speed, tighten the springs; to decrease the speed, slack off on the springs. Increasing the tension of the springs will increase the sensitiveness of the governor also, while a decrease of spring tension will cause the governor to be less sensitive, and if the governor is not sensitive enough and the speed is correct, decrease weights and increase spring tension.

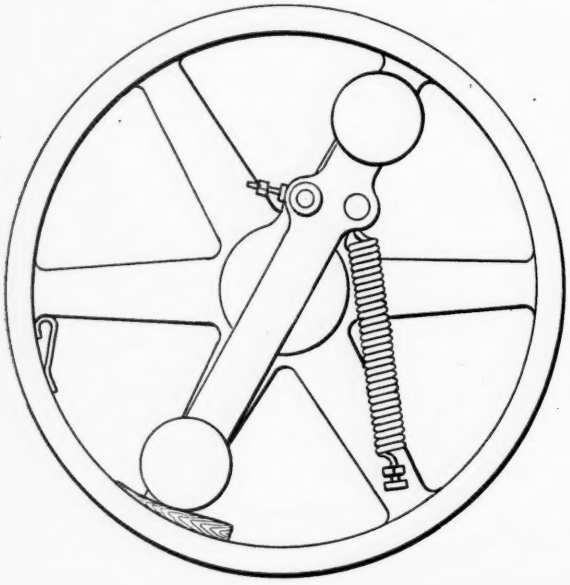
Sometimes large shaft governors will hammer on the stops, when the engine is being started, or shut down. In such cases change the weights a slight amount; then note whether hammering is increased or diminished. Sometimes this fault can be remedied by adding weight on the spring side of the arm, and increasing the spring tension.

As stated before, it sometimes happens that excessive friction in the valve, or valve gear will cause the governor to be less sensitive, in fact the engine speed may be increased several revolutions per minute by an excessively tight valve stem packing. The governor being one of the most important parts of the engine, should be cared for accordingly.

SETTING THE SWEET MULTI-PORTED VALVES

TO set the Sweet multiported engine valve it is necessary to place the crank on head end dead center and then equalize the movement of the rocker arm, provided that one is used, and then equalize the valve over the ports. The weights should then be blocked in the outermost position, Fig. 1. The valve should be on the point of opening on the head end and have the desired lead. If not, move the valve on the stem until it is in such position, then move the weights toward the center of the shaft and note whether the valve is moved. If so, the lead is variable and setting incomplete.

If the valve is not moved when the weights are moved the lead is constant. The lead should generally



GOVERNOR WEIGHT BLOCKED IN EXTREME POSITION

be not over 1/32 in. Owing to construction, the eccentric can not be moved on the shaft readily, so that giving lead at one end is all that can be done, because if the valve is moved on the stem to give lead on one end the other is disturbed.

Generally a greater lead will be found on the crank end which is done to compensate for the angularity of the connecting rod, and brings the cutoffs more nearly

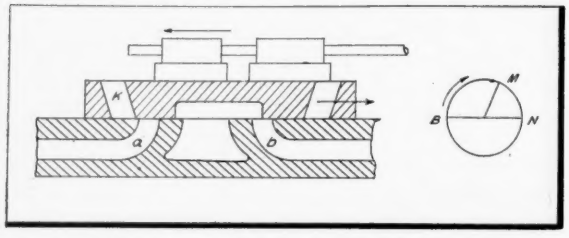


FIG. 1. PRINCIPAL FEATURES OF THE MEYER SLIDE VALVE

equal. If the crank end is blind or has no lead, move the valve on the stem until it has lead. It is good practice to secure the weights in the running position and turn the engine over, noting the points of cutoff. If any great difference is observed, lead can be changed to even up the cutoffs. Care should be taken that the lead given is not sufficient to cause the engine to race on lighter loads. The Sweet valve was illustrated and described in the August 1, 1908, issue of the Practical Engineer.

DIRECTIONS FOR SETTING THE MEYER SLIDE VALVE

BEFORE taking up the actual setting of the Meyer valve a brief explanation of its construction will be of interest. It has several different modifications but Fig. 1 will serve to illustrate its principal features. In the figure the travel is represented by the circle and the crank is on its dead center at the crank end B. The cutoff eccentric in this example is set exactly at N and the main eccentric at M. The main valve has no lead. It is apparent that the valves moving in the direction denoted by their arrows, while the crank starts in the direction shown by its arrow, the admission of steam will occur through the parts K and a uninfluenced by the cutoff valve.

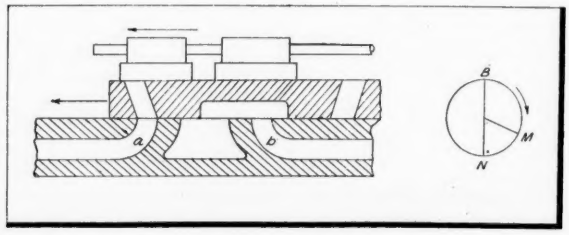


FIG. 2. MEYER VALVE AT THE POINT OF CUTOFF AND 1/2 STROKE

The relative positions of the valves, eccentrics and crank at the point of cutoff is shown in Fig. 2, the crank being at 1/2 stroke the cutoff is performed by that valve independently of the main valve action.

For the purpose of resetting this valve the eccentric and shaft are marked. Bring the marks together and screw on the set screws. If too much steam is apparently being used or the exhaust is irregular the setting of the valves should be looked to. The following instructions, if carefully followed out, will enable any engineer to do this without outside assistance.

Set the eccentric actuating the lower valve so that the angle of advance is somewhere near 15 deg. thus: Put the crank on either dead center and set the main valve at that end so that it has about 1/64 in. lead and set the nuts against valve temporarily. Turn the wheel to the other dead center and see how far the port edge of the valve is from the edge of the port. Equalize the

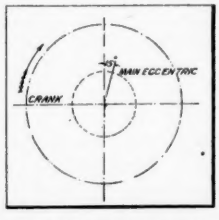


FIG. 3. CRANK ON DEAD CENTER WITH 15 DEG. ANGLE OF ADVANCE OF ECCENTRIC

leads at the 2 ends of the stroke by dividing the difference in these 2 measurements between them. When this difference has been exactly divided the nuts should be jammed up tight so they just bear against the valve and have the valve stem set to the correct length.

Having the crank at dead center, move the eccentric so that the valve has 1/64th. in. lead and fasten the eccentric; then turn the wheels to the opposite dead center and see if the lead is the same. If not, average them as close as possible. Different portions of the stroke are laid along the crosshead slide in reference to each end of the stroke; the cutoff valves are screwed on the rod together and the crosshead being set at any desired part of the stroke, the cutoff valve is moved by turning the hand wheel so that it just cuts off the ports on the main valve.

The crosshead is then moved to a corresponding position at the other end of the stroke when the other cutoff valve should just close the port on main valve. If it does not, the valve stem should be lengthened or shortened in the eye piece or one cutoff valve should be put on the stem a thread or 2 sooner than the other, thus equalizing them for both end of the stroke.

There is only one position where they will cut off exactly the same on both ends and, if varied from this, cutoff will be different on the 2 ends of the stroke, being greater relatively on one side, if increasing the cutoff and less relatively on the same side when diminishing the cutoff. In other words, the cutoff valve may be arranged to close at one-half stroke and at ¼ cutoff, one valve will be a little ahead of the other and at ¾ cutoff the opposite end will be ahead, so the best that can be done with this style of valve is to obtain one correct point of cutoff. That can be one-half or any point desired to make, but at all other points it will not be exactly correct.

A good way to get the engine on its dead center is as follows: Turn the flywheel so the piston is within an inch or so of the end of its stroke. Scribe a fine vertical line across the edge of the crosshead and guide; scribe another line across the face of the flywheel horizontally on any convenient part of the rim, guiding the scriber across the planed edge of a board nailed rigidly in position. Now turn past the center until the crosshead comes back exactly to the line and scribe across the straight edge of the rim again, then draw another line across the rim exactly half way between the first 2 and when the flywheel is turned to bring this last line even with the straight edge the engine will be exactly on the dead center. The center of the other end of the stroke may be marked in the same way, after which it can be turned to either center instantly and without liability of error.

SETTING THE VALVE OF THE PORTER-ALLEN ENGINE

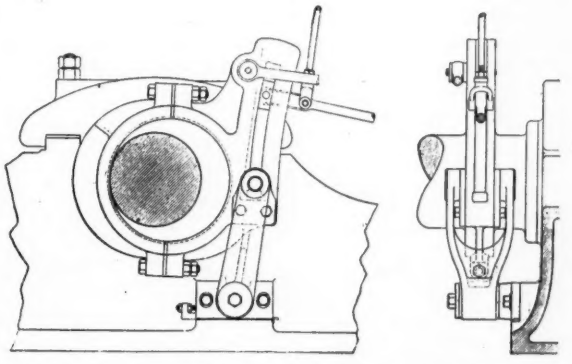
TO set the admission valves of the Porter-Allen engine, it is necessary first to place the engine on one of its dead centers, then raise the governor, bringing the center of the block between the centers of the trunions of the link. With the governor remaining up, set the valve corresponding to the dead center so that it will open the port from 1/16 to 3/16 in., according to the size of the engine, high speed requiring the greater lead. Repeat this for the other valves on the opposite center.

On letting the governor down, the crank remaining on the dead center, it will be seen that the valve is moved a short distance. This motion of the valve, produced by moving the block from the trunions to the extremity of the link while the crank stands on the center, is the same in amount on either center, and takes place in the same direction, namely towards the crank. Its effect is, therefore, to cover the port nearest to the crank, and to enlarge the opening of the port farthest from it; so that the lead, which is equal at the earliest point of cutoff is gradually diminished at the crank end of the cylinder and increased at the back end in the same degree as the steam follows farther.

The effect of this is to equalize the opening of cutoff movements so that, on setting the governor at any elevation whatever and turning the engine over, the openings made by the point of cutoff will be found to be identical on the opposite strokes from the commencement up to the maximum admission.

The exhaust valves have an invariable motion. They are set so as to open before the end of the stroke, enough to give ample exhaust lead, and close again when the piston is on the return stroke, early enough to affect the required compression, say about 1/5 stroke.

All valves are held between pairs of brass nuts, of which the inner one is flanged. These nuts must be



ECCENTRIC AND LINK OF THE PORTER-ALLEN ENGINE

securely locked and should be so set upon the valves that the lever is free to adjust itself between the nuts, while tight enough to prevent lost motion. To avoid the consequence of a mistake, care should be taken before closing the valve chests to turn the engine slowly through an entire revolution, while the movements of the valve are carefully watched, to be sure that they have not been so set as to bring the valves or the nuts in contact with the ends of the chest at the extremities of their movemens.

To keep the admission valves tight, when the engine is warmed up to its usual working condition, open the indicator cocks, or, if these are not on, remove the plugs from the top of the cylinder, unhook the link rod and set the valves by the starting bar so that both ports are covered; then turn on the steam. If the valve leaks at the end of the cylinder, which is not then open to the air or the condenser, the steam will blow out at the opening provided. This will indicate that the pressure plate should be lowered slightly toward the valve, which is accomplished by turning its adjusting bolt backward slightly. The valves should move freely when the leak has disappeared and the pressure plate should be let down no closer than is necessary. An engine should never be started until it is warmed up, as the valve warming quicker than the supports on which the pressure plates rest are liable to be cracked between the pressure plates and seats.

SOMETIMES THE ENGINEER realizes that the salesman is promising impossibilities, and then the salesman wonders why sales are slow.

SETTING THE VALVES OF THE PUTNAM ENGINE

TO set the valves of a Putnam engine is it necessary to establish a method of designating the different valves in order to give directions. If the observer stands facing the side shaft they will appear as follows: The left hand exhaust valve No. 1, left hand steam valve No. 2, right hand steam valve No. 3, right hand exhaust valve No. 4, the regulator stands, of course, between the 2 steam valves. See Fig. 1. These are all poppet valves. The steam valves are operated by cams which trip and allow the valves to be closed by a spring.

The operation of setting is as follows: 1st, With the regulator attached to the valve gear raise the governor balls as high as they will go (Fig. 2) and block them in that position. Next push in the steam levers of valves 2 and 3 so as to allow the cams which operate them to be revolved on the shaft without lifting the valves; that is, the valves are thrown out of control of the cams.

With these levers in the position given, tighten the set screws in the rocker arm which runs from the bottom of the regulator rod to the lower side shaft so that the arm will be fast to the shaft. The balls of the governor may then be lowered and the regulator adjustment

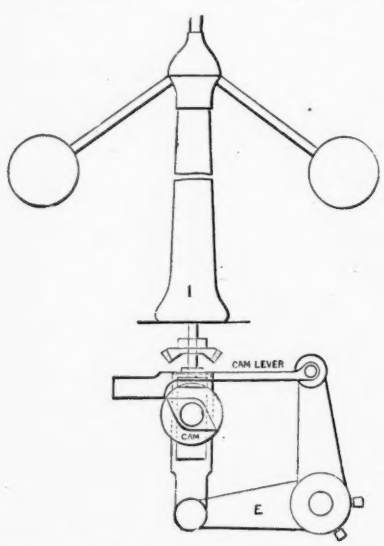


FIG. 2. REGULATOR BLOCKED IN POSITION FOR SETTING VALVES

is finished. This is for the old style regulator which has the Scotch yoke connected to the governor spindle.

In the new style, which has a link motion arrangement, the connections are made and governor balls raised until clearance between the counter weight and the collar above this weight is ¼ in. The balls are then blocked in that position and the levers of valves 2 and 3 pushed in far enough to allow the cams to operate as with the old style regulator.

If the engine is to run over, the bevel gear at the end of the lay shaft should be on the inside of the gear on the stud. If the engine is to run under, the lay shaft gear should be at the end of the shaft. The shaft revolves in the same direction always, but changing the position of the gear reverses the engine shaft.

With the gears secure on the shaft, the crankpin is put on the inner dead center. Beginning with valve 2 and with the valve closed mark the stem 1/16 in. below the packing box and turn the cam in the direction it is to run until the mark on the valve stem has come flush to the stuffingbox. Make the cam fast to the shaft by tightening up the set screw. This gives 1/16 in. lead or valve opening when the crank is on center.

The cam on the exhaust valve 4 is treated in exactly the same manner as was that for steam valve 2, except that the mark is placed 3/16 in. below the packing box so as to give 3/16 in. exhaust lead.

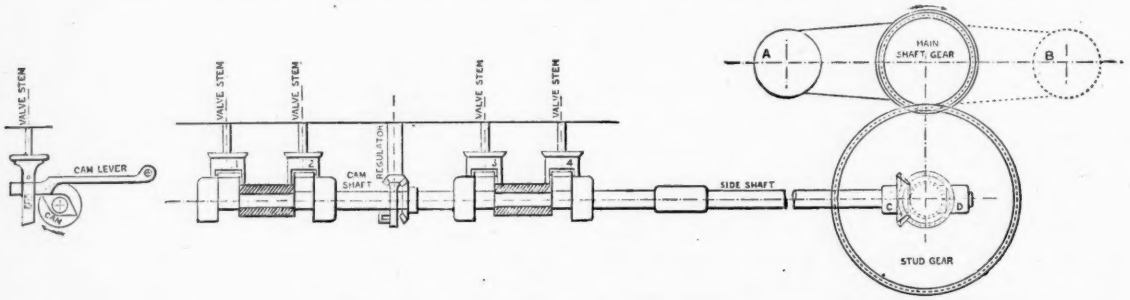


FIG. 1. DIAGRAM OF SIDE SHAFT SHOWING LOCATION OF VALVES AND REGULATOR

Steam valve 3 is set the same as No. 2, with the crankpin at the outer dead center and 1/32 in. lead allowed, and exhaust valve 1 is set the same as 4 with 3/16 in. exhaust lead. The rock shaft which operates cam levers 2 and 3 has leather lined caps in the bearings in order to give a slight friction and prevent unsteady action of the governor. These caps should be kept tightened just enough to produce the desired steadiness without undue friction, for too much friction will cause the governor to be sluggish. An indicator should, of course, be applied after the valves are set to test the correctness of the card.

DIRECTIONS FOR SETTING THE VALVES OF BROWN ENGINE

THE first operation in the setting of the valves of the Brown engine is the proper adjustment of the 4 valve stems in order to secure the necessary lap on each valve. Beginning with the steam valves, remove guide box A, shown in Fig. 1, and on the valve gear bracket a scratch mark B, prick punched at each end, will be found. Now disconnect the dashpot connections from steam valve stem guide D, and allow the valve to drop as far as it will go and then adjust by turning the valve stem in or out of the valve nut until a distance between the scratch mark B on the valve gear bracket and the bottom of the brass drip cup C is the exact width of the steel gage or ⅞ in. Then make the stem fast to the guide by means of nuts at E.

The dashpot stem G should then be adjusted until the top prick punched scratch mark on guide D just shows above the top of the guide box. Tighten the nut on the dashpot stem. Make these adjustments on both steam valves. Now turn the full side of the

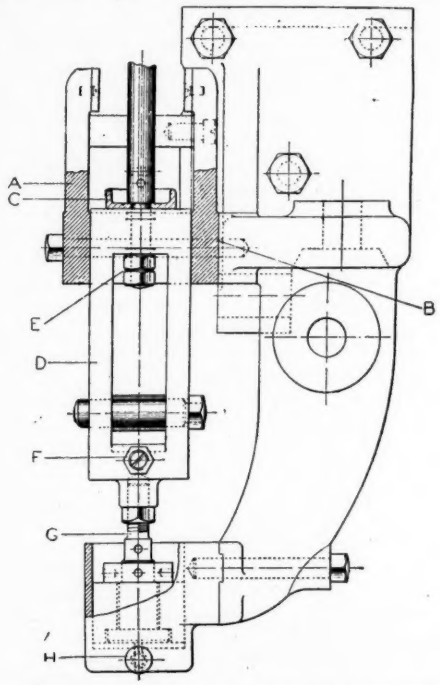


FIG. 1. STEAM VALVE AND DASHPOT OF BROWN ENGINE

steam eccentric to the forward or dead center farthest from the cylinder, having first seen that the dashpot on the crank-end steam valve is properly seated. When the eccentric occupies the dead center the lifting block

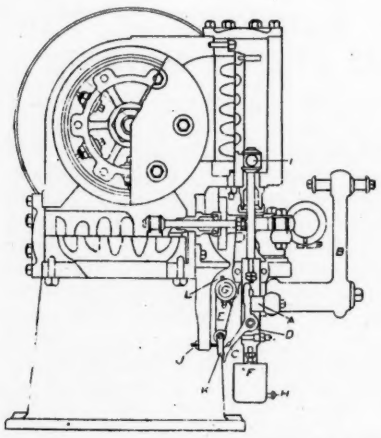


FIG. 2. SECTION THROUGH CYLINDER AND VALVES OF BROWN ENGINE

A of the crank end, shown in Fig. 2, should have just engaged the latch with perhaps 1/32 in. clearance. If this is not the case the eccentric rod should be adjusted until this clearance is obtained.

When the eccentric occupies the dead center nearest the cylinder, see that the foregoing conditions are fulfilled at the head end or the end of the cylinder farthest from the crank shaft. If the proper clearance is not obtained, adjustment must be made by the right and left rod connecting the 2 steam levers until the proper clearance is obtained on the head end. Now turn the eccentric around on the shaft and see that both valves are alternately raised an equal distance which will be the case if the adjustments have been properly made.

Place the crank and the full side of the eccentric on the dead center nearest the cylinder. The lifting block

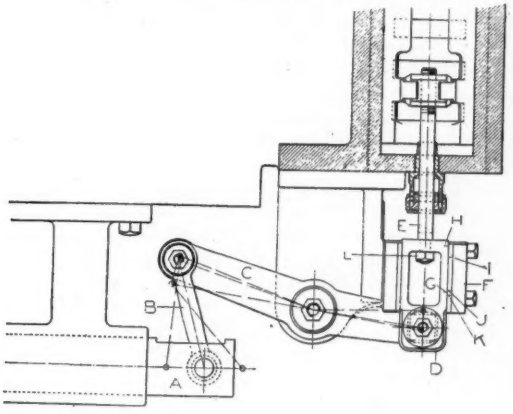


FIG. 3. BROWN EXHAUST VALVE MECHANISM

now should just have engaged the latch on the head end. Have the eccentric turned around on the shaft in the direction in which the engine is to run after the valve opens the ports the amount of the lead, which should not exceed 1/64 in., unless it is positively known that the engine will run better with more lead. Have the eccentric fixed to the shaft at this point. The amount of lead may be accurately determined by removing the upper heads of the valve chests and meas-

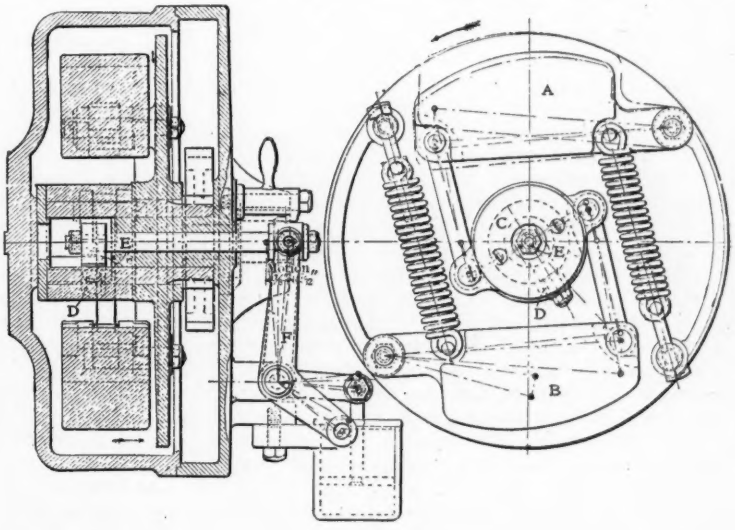


FIG. 4. THE BROWN GOVERNOR

uring the lead by means of a thin steel 1/64 in. thick. The end of the steel strip is to be placed against the valve seat while the eccentric is being slowly turned around on the shaft. As soon as the strip enters the port, the valve will have opened the port 1/64 in.

Have the crank turned in the direction it is to run to the opposite dead center or crank end. The opposite steam valve should now have opened the port the amount of the lead, which it will do provided the work of equalizing the movement of the valve has been properly done. If the lead is found to be correct the eccentric must then be permanently fixed in the position in which it will now be found on the shaft.

The movement of the exhaust valve is now to be equalized in the same manner as for the steam valves. Marks will be found on the exhaust valve stem guide D, Fig. 3, and on the guide box F, showing the position of the valve. Should the marks have become obliterated, the valves may be seen by removing the valve chest bonnets and by the aid of pieces of thin steel their exact location may be determined the same as with the steam valves.

To determine the proper length of the exhaust valve stem, draw the valve forward until it strikes. Screw the valve stem into the valve nut until marks H and I come together, then tighten the nut L. The lines J—K show the lap of the valve; G and J, when together, show the opening line.

To set the exhaust valves mark the guides on the frame at each end, varying from 2½ in. for small engines to 3 or 3½ in. for the larger ones, from the full stroke or end of the crosshead guide. Then have the crank turned in the direction the engine is to run until the crosshead reaches one of these marks.

Assume that the exhaust eccentric is on the dead center nearest the cylinder, and that the crosshead has reached the line on the guide nearest the cylinder. The exhaust eccentric is now to be turned around on the shaft in the direction the engine is to run until the exhaust valve on the head end just closes the port, or until lines G and J come together. Fix the exhaust eccentric to the shaft at this point. Then have the crank turned in the direction it is to run until the crosshead reaches the line at the opposite end of the guides, when the exhaust valve at the end of the cylinder should have just closed the port also.

If it does, the compression will then commence when the piston reaches a point from the end of the stroke corresponding to the distance marked on the frame or guides.

The proper amount of compression and lead will have to be finally determined by means of the indicator with the engine running under working conditions. This should be done in all cases, because an engine running condensing will require more compression than an engine running noncondensing.

After both sets of valves have been carefully adjusted, attention should be given to the governor shown in Fig. 4. Loosen the governor springs until the weights can be readily moved from one position to the other by means of the central stem. Now press the stem in until the weights are in the outer position and block them. Loosen the set screw in the governor connection lever on the trip lever E nearest the governor, which is permanently fastened to the trip shaft, either toward or away from the latch, as the case may require, until the crank end steam valve upon being raised will cut off when the second prick punched scratch mark on the guide D appears on the top of the guide box. Then tighten the set screw in the governor lever on the trip shaft; that is, with the governor weights in their outer position, the steam valve is only allowed to lift enough to just uncover the lap. The lap is the distance between the first and second scratch marks.

Place the small handle on the front of the governor in the vertical position and pull the stem out until it is stopped by the handle, which will bring the governor weights to their inner position. The steam valve now being raised should not fall until the third prick punched scratch mark shows at the top of the guide box, or 1/16 in. less than the full throw of the short horizontal arm of the steam lever B. The movements of the 2 steam valves may now be equalized by means of the taper pin L, in the trip lever of the head and steam valve. This pin can be readily seen, and acts as a taper key. By loosening the set screw and driving the pin in, the cutoff is shortened, and by driving it out the cutoff is lengthened.

With the small safety stop handle in the horizontal position and the central stem pulled out as far is it will go, the governor balls are allowed to reach an extreme point beyond their inner governing position, which imparts to the central stem an extra 7/32 in. motion beyond its working limit. Block the governor in this position. Now screw J, Fig. 2, in until the lower end of the pawl K strikes the tail of the latch C, and the steel on the upper end of the latch is just thrown out of engagement with the lift block A. Tighten the check nut on screw J.

This adjustment being made at both ends of the cylinder, each valve should be raised 2 or 3 times to see that clearance has been properly given between the steel on the latch and the lifting block, so that the latch cannot hook on at this point. It will be seen that should the governor belt break, or from any other cause the governor balls be allowed to reach their extreme inner position, the steam valves will remain seated, thus cutting off steam to the cylinder. This is an efficient and positive device and should be the means of saving the engine from destruction in case of accident to the governor. The safety stop handle should always be in a horizontal position while the engine is running, being moved to the vertical position just previous to shutting down.

DIRECTIONS FOR SETTING THE VALVES OF PISTON ENGINE

THE eccentric should be placed on dead center next to the cylinder and scribe a mark on the valve stem and guide, which mark can be made to return the parts to their original position should occasion require to make a fresh start, which would otherwise be found difficult when the edges of the valve and steam ports cannot be seen easily. After marking the original position of the valve gear, disconnect the valve stem from the guide block, take off the back steam chest cover, pull out the valve and stem and remove the other check cover; make a template of thin sheet iron about an inch wide and about as long as the thickness of one end of the pistons of the valve plus the lead.

Place the template against the inner side of the head end port A, as shown in Fig. 1, and with a scriber, make a fine mark on the other end of the template, B. In case the valve pistons are both of the same length, repeat the operation at the opposite end of chest, using the same template. If, however, as sometimes happens, the valve piston on the crank end of the chest is of a different length, a new template must be made for locating the valve on this end of the chest. Now, place the valve in the chest and connect up the valve gear to its original position.

It will be observed that the effect of admitting steam to the inside of a piston valve, or between the valve pistons, is the same as adding a rocker shaft to the valve gear of a slide valve engine, as the valve travel is opposite that of the piston when the latter is at or near the dead center; therefore, after placing the crank on the dead center nearest the cylinder, turn

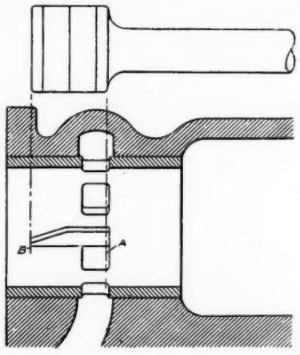


FIG. 1. DETERMINING THE LEAD OF A PISTON VALVE

the eccentric on the shaft in the opposite direction to that in which the engine is to run until the outer end or edge of the valve just coincides with the fine line, B, drawn on the valve seat farthest from the

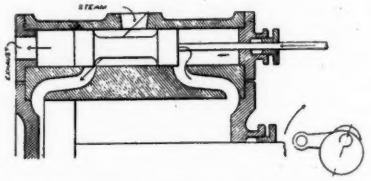


FIG. 2. PISTON VALVE OPEN TO THE AMOUNT OF THE LEAD, SHOWING RELATIVE POSITIONS OF THE CRANK AND ECCENTRIC

crank. The inner edge of that piston of the valve will then open the steam ports to the amount of the lead as in Fig. 2. Fix the eccentric to the shaft and turn the crank to the opposite dead center when the outer edge of the valve at the opposite end of the crank should coincide with the line drawn on the valve seat.

If it does, then the inner edge of that piston of the valve also opens the steam port to the amount of the lead and the valve will have been correctly set. Any difference between the leads on the 2 ends may be equalized by adjusting the valve stem at the guide block and the setting of the valves should, if possible, be verified with the indicator.

DIRECTIONS FOR SETTING VALVES OF THE BUCKEYE ENGINE

WHEN the shop marks have, for any cause, disappeared from the valve stems in the piston valve engine, the work of re-establishing them is somewhat more complicated than setting the slide valve. As the working edges of these valves cannot be readily seen when the latter are in place, it becomes necessary to remove the valves, and after properly locating them relative to each other, the several positions must be accurately marked by means of suitable lines or punch marks placed at unchangeable distances on the valve stems.

Provide a clean place on the floor or bench where the valves are to be placed. Remove the valves from the chest and place them on the bench. Make a tram or gage similar to that shown in the illustration, Fig. 1. First place the cutoff valve in its position of midtravel, and by aid of the tram make a mark on its valve stem. Mark this position of the cutoff valve on the stem also, then move it in the opposite direction until it closes the port in the main valve, which position is to be similarly marked. Now remove the cover A, then the cutoff valve and measure the distances E and D.

Place the main valve in the chest and move it along until the port in the main valve opens the port into the cylinder wide and almost closes it again, leaving the port open to the amount of the lead, which may be seen or determined by a piece of steel in the smaller sizes. This should not exceed 1/16 in. With one end of the tram placed against the gland, mark this position of the valve on the main valve stem, then push the valve along still further a distance equal to D minus E, plus 1/8 in. if the lead is 1/16 in. Then the port in the main valve will have opened the port into the cylinder at the opposite end 1/16 in. Mark

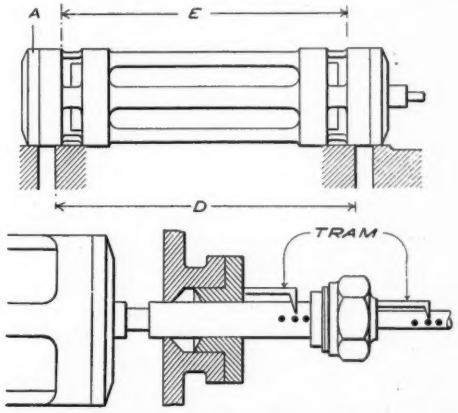


FIG. 1. A SIMPLE FORM OF TRAM USED FOR SETTING THE VALVES OF THE BUCKEYE ENGINE

this position of the valve on the main stem also. When moving the valve, as just directed, the distance indicated by the formula is to be determined by measurements carefully made between the end of the valve on a straight-edge placed across the end of the chest.

Now put in the cutoff valve and replace the cover A. Connect the main valve rod to the valve stem and turn the eccentric from one dead center to the other, seeing that the outer marks on the valve stem move equal distances beyond the point of the tram. It will be understood that the outside marks do not represent the travel of the valve, but twice the lap plus twice the lead; therefore the outside marks will have moved beyond the point of the tram when the eccentric occupies either dead center. If they do not, adjust the length of the eccentric rod until these conditions are fulfilled.

Place the main valve in its position of midtravel, which may now be accomplished by means of the marks on the valve stem and the tram. Tighten the set screws in the main eccentric so as to hold the valve in its position of midtravel. Connect up the cutoff valve with its eccentric and proceed to adjust the length of the eccentric rod by turning the cutoff eccentric attached to the governor wheel around on the shaft, seeing that the marks on the cutoff valve stem

move equal distances beyond the point of the tram in the same manner as with the main valve, correcting any inaccuracies by adjusting the length of the cutoff eccentric rod.

The valves will now be ready to be set, which is done in precisely the same manner as for slide valves, except that the piston valves are set according to the marks on the valve stems instead of by sight, as is possible in the former case.

When using a tram in setting engine valves, care must be taken to select a suitable point on the engine —one which will not be affected by future adjustments

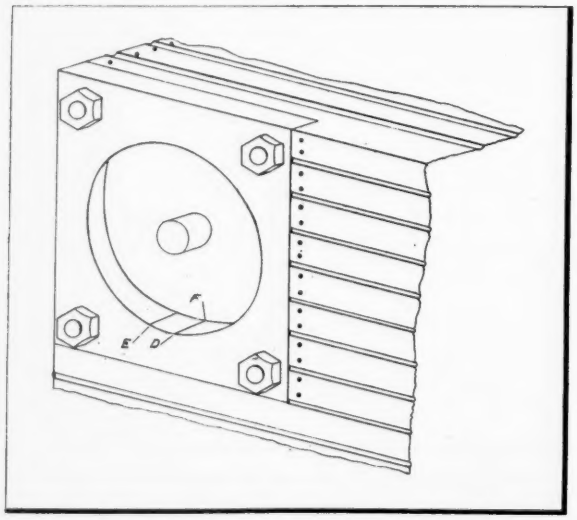


FIG. 1. MARKS ON THE VALVE END AND SEAT

and which will permit the tram to be placed parallel to the valve stems or other rods upon which similar measurements may be taken.

Placing the tram at only a slight angle in any direction may be the means of doubling the lead. At any one end of the valve, and robbing the other end of lead altogether. One method of obtaining correct measurements of this which is recommended by the

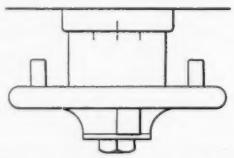


FIG. 2. WRISTPLATE IN CENTRAL POSITION SHOWING MARKINGS

Buckeye Engine Co., is to remove the packing from the stuffing box, carefully clean the faces of the box and glands and then push the gland home; that is, push or screw it up tight against the face of the stuffing box. This permits the tram or scale to be placed on the stem and against the gland, the latter becoming a fixed point under these conditions.

A QUESTION REQUIRING expert consideration is propounded by the chief engineer of a large power house: "What is the best method to get a cat accustomed to a power house so that she will not yowl in synchronism with the alternator and cause eddy currents between the smokestack and the ashpan? Our cat sings so that the overtones and harmonics are producing surging on the line."

CORLISS VALVE SETTING

By JOHN M. LEITCH

ALTHOUGH directions for valve setting are numerous, the following have some methods not commonly given and which are worth remembering: First remove the steam and exhaust bonnets and upon the end of the valve will be found a mark corresponding to the opening edge of the port. The direction of motion for opening the

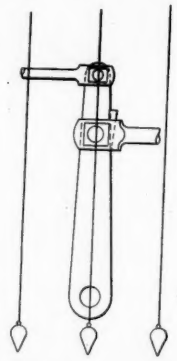


FIG. 3. PLUMBING THE ROCKER ARM

valve can be determined by working the wristplate by hand.

Second, examine the wristplate hub and bracket. Upon the bracket will be found a mark corresponding to the central position of the wristplate and 2 others locating the extreme travel of the wristplate in either direction of motion.

Third, see that the rocker arm travels an equal distance each side of the vertical position. To do this

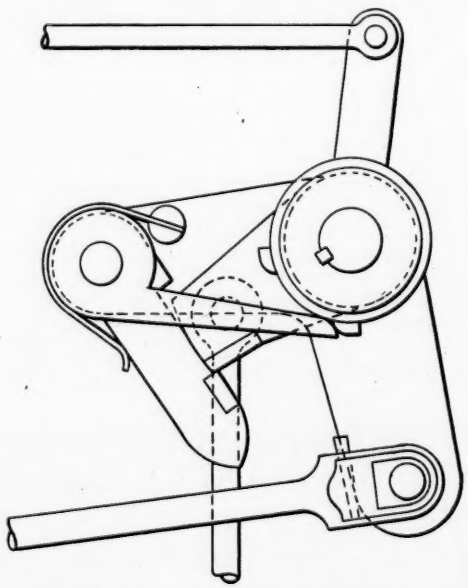


FIG. 4. DETAILS OF SAFETY CAM CATCH BLOCK AND HOOK

loosen the eccentric and rotate it slowly about the shaft. Then with a plumb bob and scale measure the distance the rocker arm travels each side of its central position, adjust the length of the eccentric rod to bring the distances equal.

Fourth, rotate eccentric about the shaft and see if the wristplate travels equal distance each side of its central position, as shown by the travel marks. If it does not, adjust the length of the hook rod to bring them equal.

Fifth, block the wristplate in its central position, then pull up the dash pot rods until the hook pin en-

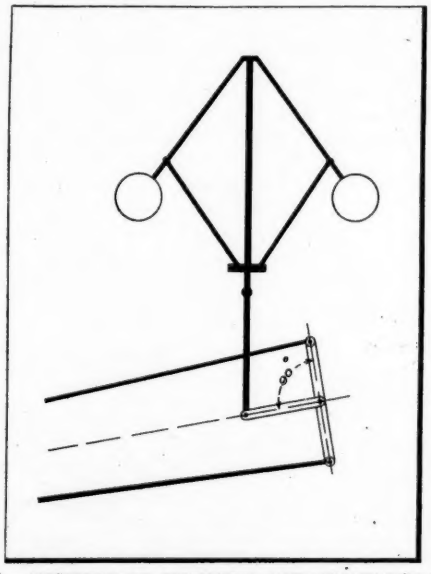


FIG. 5. POSITION OF GOVERNOR AND REACH-ROD BELL CRANK

gages with the steam hooks. Adjust the length of the steam and exhaust radius rods until the valves have the proper amount of lap as determined by the size and speed of engine.

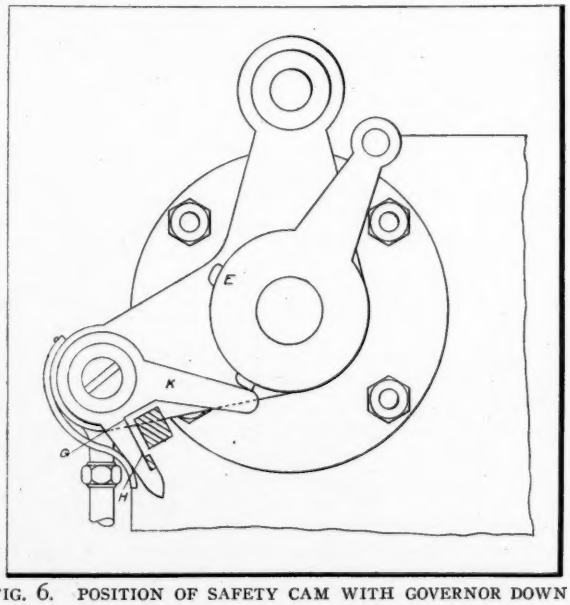


FIG. 6. POSITION OF SAFETY CAM WITH GOVERNOR DOWN

Sixth, throw the wristplate with the starting bar first to one, then to the other extreme position and adjust carefully the length of the dash pot rods so that the steam hooks will latch with the hook pins when the wristplate is at its extreme travel, allowing 1/32 in. for clearance.

Seventh, place the engine on dead center and see that the hook rod is fastened to the wristplate. The eccentric should then be turned in the direction the engine is to run until the proper amount of lead is secured, as per the table, fasten the eccentric to the shaft and place the engine in the opposite dead center and measure the lead. If it is not the same, make it the same by adjusting the length of the steam radius rods.

Eighth, block the governor up half way in the slot and fasten the reach rod levers at right angles to a

LAP, LEAD AND TRIAL COMPRESSION FOR CORLISS ENGINES

DIAM. OF CYLINDER IN INCHES	STEAM LAP IN INCHES	STEAM LEAD IN INCHES	EX. LAP IN INCHES	TRIAL COMPRESSION IN INCHES
10 & 11	1/8	1/64	1/8	1 3/4
12 & 14	5/16	1/32	"	2 1/4
16	1/4	"	"	2 3/8
18 & 20	3/8	"	"	2 5/8
22 & 28	7/16	3/64	5/32	2 7/8
30 TO 34	15/32	1/8	3/16	3 1/2
36	1/2	"	7/32	4
40 & 42	9/16	"	1/4	"
44 TO 48	5/8	5/64	5/16	"

line drawn half way between the 2 rods. Adjust the length of the reach rods until the knockoff arm stands vertical; with the governor in this position turn the engine over until the cutoff occurs, and measure carefully the distance the crosshead has traveled; place the engine so that it will be the same on the other side, and adjust the length of the reach rod until the cutoff will just occur. This insures equal cutoff at each end of the cylinder for these positions. See that the governor gag pot is properly adjusted, and that the pot is filled with light oil.

Ninth, drop the governor to its lowest position and see that safety chip on the knockoff lever are adjusted so as to prevent the steam hook from latching with the hook pin.

Tenth, tram your engine with a fine prick punch so as to be able quickly to adjust it in case of accident or in case it has been tampered with.

ADJUSTMENT OF CORLISS ENGINE VALVE GEARS WITH TWO ECCENTRICS

IN order to obtain a greater range of cutoff in a Corliss engine, a separate steam and exhaust eccentric is used. With 2 eccentrics the admission and exhaust valves can be adjusted independently, and steam may be cut off anywhere nearly to the end of the stroke.

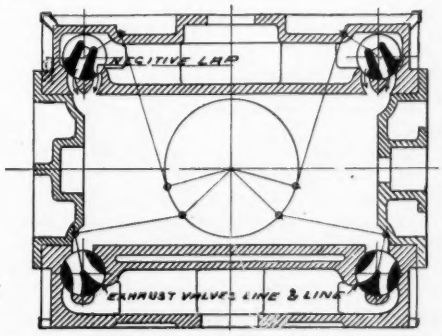


FIG. I. CENTRAL POSITION OF WRISTPLATE

The work of setting the valves of a Corliss engine having 2 eccentrics is not particularly complicated, as

many engineers seem to think. After knowing in which direction the engine is to run, finding the direction in which to turn the eccentric becomes a very simple matter. When setting the steam valves we have one eccentric to turn, as in the case of the single eccentric engine, and when setting the exhaust valve another eccentric must be turned, but this does not add complication to the work, although it requires a little more time. The work of centralizing the positions of the various parts, equalizing the movements and setting and adjusting the valve gear, is practically the same as with the single eccentric engine.

Set the wristplate central, as shown in Fig. 1, and adjust the valve rods, but in this case the steam valves

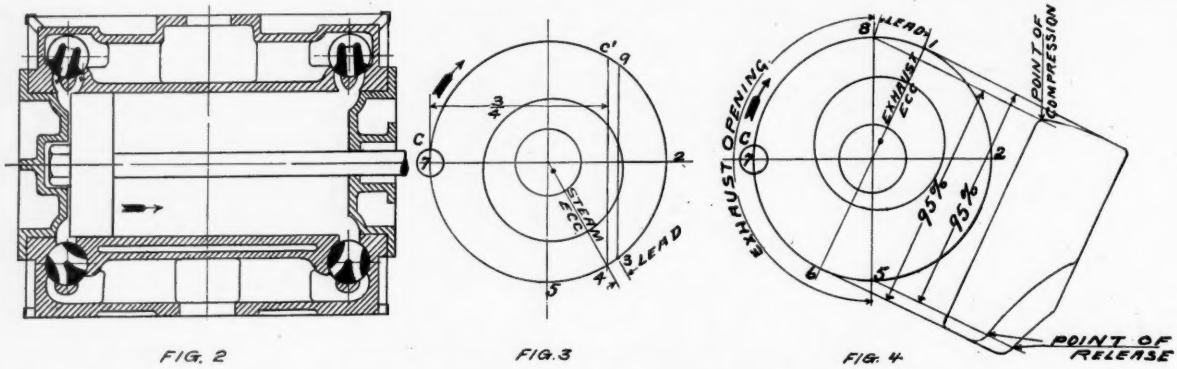


FIG. 2 FIG. 3 FIG. 4

FIG. 2. POSITIONS OF VALVES WHEN CRANK IS AT DEAD CENTER AND ECCENTRICS PLACED AS SHOWN IN FIGS 3 AND 4

FIG 3. STEAM ECCENTRIC DIAGRAM SHOWING CYCLE OF EVENTS AS IMAGINARY MOTION IS CARRIED OUT

FIG. 4. DIAGRAM OF EXHAUST ECCENTRIC WORKING UNDER SIMILAR CONDITIONS TO THE STEAM ECCENTRIC

are set with negative lap, which is usually a little less than half the port opening. The first step is to set the exhaust eccentric (as it is placed next to the bearing), then turn the engine until the piston is in the desired position, as shown in Fig. 5, so as to obtain a compression of about 5 per cent of the stroke, then turn the exhaust eccentric loose on the shaft, in the direction the engine is to run, until the exhaust valves are line and line; then secure the eccentric.

The next step is to set the steam eccentric; place the crank on either one of its dead centers, then turn

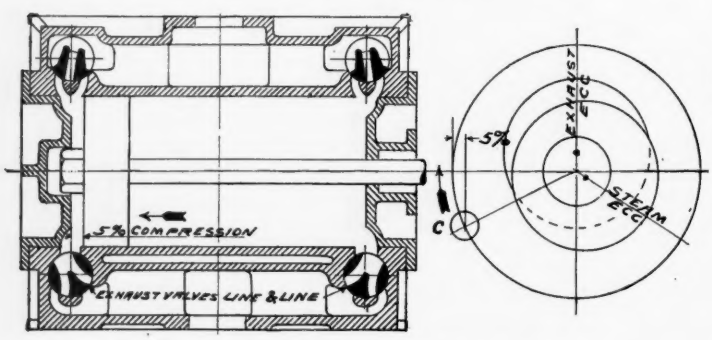


FIG. 5. DESIRED POSITION OF PISTON FOR OBTAINING PROPER COMPRESSION

the steam eccentric loose on the shaft until the steam valve at the end where the piston stands has the required opening or lead, which varies from 1/32 in. to 1/8 in., according to the size and speed the engine is to run.

Separate eccentrics require separate wristplates, which are usually placed on the same pin. Figures 2, 3 and 4 show how the eccentric may be placed on the shaft. The steam eccentric is at point 4, Fig. 3, the exhaust eccentric is at point 1, Fig. 4, and the crank is at its dead center at C. Individual eccentric circles are shown for the sake of clearness. An imaginary motion of the eccentric will point out the various events. Referring to Fig. 3, near point 2, at the end of the throw, the hook connects with the steam valve; at point 3 the steam edges are at the point of separating, and the eccentric motion 2-3 determines the initial valve motion. When the eccentric is at point 4, the crank is at its dead center, as shown. At point 5, the steam wristplate is in its central position, and in that position the valve does not cover the port, as with the single eccentric gear, but the port is open to a certain extent, determined by the eccentric motion 3-5. Point 7 marks the end of the throw and the corresponding position of the crank is at C′ at about 3/4 of the piston stroke, and the limit of cutoff is a little later.

If the hook does not strike the knockoff cam, the valve will remain open until closed by the return

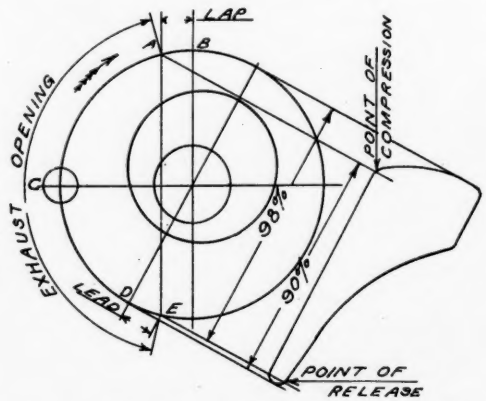


FIG. 6. EFFECT OF LAP ON EXHAUST VALVES

stroke of the eccentric at point 9, near the middle of the return piston stroke. The exhaust action is discernable from Fig. 4. It is similar to the single eccentric action, but with this difference: that the release at point 5 occurs at about 95 per cent of the stroke, and the exhaust is also cut off at about 95 per cent of the return stroke at point 8.

The motion of the exhaust valve, after it has

closed the port, is determined by the eccentric motion 8-2-5, and full period of exhaust opening is obtained by the eccentric motion 5-7-8. In case the exhaust valve motion is designed and set with lap, Fig. 6 shows the effect lap has on the exhaust valves. The lap, when the wristplate is central, is determined by motion A-B; it will be noticed that the compression begins at A about 90 per cent of the stroke, and the release at E occurs at 98 per cent of the return stroke, and the exhaust opening, E, C, A, is shortened.

Where lap is used on the exhaust valve, it has the effect of making earlier compression and later release. A valve gear designed to be operated by a single eccentric cannot very well be made to cut off much later than at half stroke, even when a separate eccentric is added, for the slow initial valve motion requires at least half the throw of the eccentric, and the other half is not sufficient for a late cutoff. However, the range of cutoff may be extended by moving the eccentric back, sacrificing the lead, and to this there is no objection when it does not involve later release.

The advantage gained by a second eccentric would consist of more compression and earlier release. After setting the valves and making the final adjustment, it is necessary that an indicator be applied to the engine when at work to verify the adjustments of the valves for the best possible conditions for economical operation.

A VOLUMETRIC STEAM ACCUMULATOR

By Francis G. Wickware

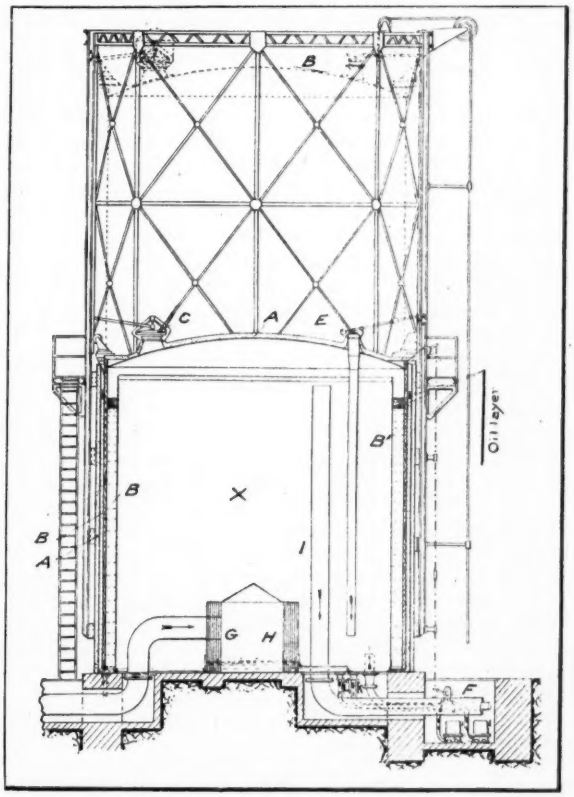
THE first commercial installation of a new type of steam accumulator, the Harle-Balcke patent, at the Carl shaft of the Cologne Mining Co., near Cologne, Germany, is described in a recent issue of Gluckauf. As will be apparent from the accompanying diagram, the new accumulator resembles closely in principle and design the common form of gas holder. A bell 26 ft. 3 in. in diameter and 23 ft. high, floats in water in the annular chamber B between 2 concentric circular walls 21 ft. 10 in. in height, the outer of which has an external diameter of 26 ft. 9 in. Rollers running on tracks carried by a structural-steel framework guide the bell in its vertical movements. The whole apparatus rests on a concrete foundation.

Exhaust steam from a hoisting engine and a reciprocating air compressor enters the accumulator at G, and after passing through the oil separator H is admitted to the steam chamber X. Steam is led from the accumulator to a mixed-pressure turbine through the pipe I. Water of condensation is drawn off at K, and oil-carrying water from the oil separator at L. The safety escape valve C opens automatically when the accumulator is filled to the full extent of its capacity, which is 10,100 cubic ft.

Special arrangements are provided to prevent the establishment of a vacuum in the accumulator by complete exhaustion of the steam. The valve E opens automatically to admit air to the steam chamber when the bell is within 8 in. of its lowest position, but as it is inadvisable to admit air to the accumulator, because of its effect on the working of the turbine condensor, the valve F is arranged to admit live steam when the bell reaches a point 33 in. above its lowest position. The valve E operates, therefore, only when neither exhaust nor live steam is available.

Evaporation of the water in the annular chamber is prevented by a layer of oil. The wall of the bell is sheathed with a double layer of oak planks, and over both wall and top asbestos is laid to a depth of 2 in. This insulation has proved effective in preventing condensation of steam. Recent tests have shown that the condensation over the 3,820 sq. ft. of surface of the bell is only 198 lb. an hour, out of a total of 15,400 lb. of steam admitted to the accumulator.

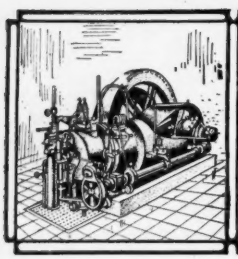
In steam accumulators of the ordinary Rateau type, the pressure varies between 1.1 and 1.3 atmospheres absolute. This pressure reacting, as a back pressure, against the exhaust has a prejudicial effect on the economy of a reciprocating engine exhausting into a Rateau accumulator. The advancing of the Harle-Balcke accumulator over earlier types lies in the fact that the steam pressure never rises above 1.03 to



A NEW TYPE OF STEAM ACCUMULATOR

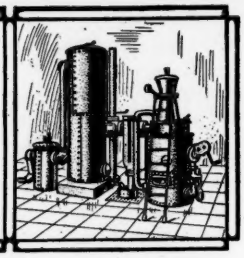
1.04 atmospheres absolute; hence, reciprocating machines exhausting into these accumulators operate under conditions of practically free exhaust.

The extremely low and regular pressure of the steam in a Harle-Balcke accumulator involves the employment of a turbine-governing mechanism radically different from that applicable to turbines supplied by Rateau accumulators. In accumulators of the latter type, the considerable variations in internal steam pressure are utilized to effect the regulation of the turbine admission valve. Since the Harle-Balcke accumulator is designed on a purely volumetric principle, such small variations of internal pressure as occur are entirely inadequate to serve as a means of turbine regulation. Recourse is had, therefore, to the vertical movements of the bell, which are transmitted to the turbine admission valve through the medium of oil under pressure.



Gas Power Apparatus

Producers, Engines and Industrial Applications



ANNUAL CONVENTION OF NATIONAL GAS ENGINE ASSOCIATION

HELD AT CLEVELAND, O., DEC. 5 TO 8

LARGER attendance than ever before, particularly of the builders of gas engines of large size, an attractive exhibit, attractively arranged, live discussion on important questions of policy, and interesting papers on gas engine performance, marked the meeting and made for its success. In addition, the warm hospitality of the Cleveland hosts and their ample provision of interesting entertainment contributed to a delightful as well as profitable convention.

While, as the combined judgment of those present, the time has not yet arrived for some of the forward steps which were proposed, the discussion has served to make clear the importance of progressive and combined action and the improvements which were planned and put in force will add greatly to the usefulness of the association.

The meeting place for next spring was chosen as Milwaukee, and the newly elected officers are: For president, O. C. Parker of the Sta-Rite Engine Co., La Crosse, Wis.; for vice-president, H. W. Jones, of the Peoples Gas, Light and Coke Co., Chicago; for secretary, Albert Stritmatter, of the Gas Engine Publishing Co., Cincinnati; for treasurer, Otto M. Knoblock, Knoblock-Heideman Co., of South Bend Ind.; for executive committee, Chas. O. Hamilton, Elyria Gas Engine Co., Elyria, O., H. W. Bolens, of the Gilson Mfg. Co., Port Washington, Wis., and O. B. Iles, of the Capitol Gas Engine Co., Indianapolis, Ind.

The following are abstracts of the papers presented at the technical session.

GAS ENGINE POWER

By Howard Dingle

IN the early days the gas engine was looked upon as a somewhat unsatisfactory form of prime mover, due to the flicker in the lights caused by the irregular impulse in the engine, which was transmitted through the belt to the generator, causing the voltage to flicker, and naturally the lamps on the circuit also. This necessitated the use of a heavy flywheel on the engine, and a flywheel pulley is still a desirable asset on a small generator driven from a single cylinder gas engine with the hit-and-miss type of regulator. With the improvement that has taken place in the gas engine art, this trouble, it may be truthfully stated, has been entirely eliminated.

Turning to the larger units for both light and power for industrial purposes, the introduction of the multiple cylinder engines was a big step in advance in improving the speed regulation and for successful parallel operation of alternating-current generators where the units are of the direct connected type, the multi-cylinder construction is essential for satisfactory results.

Generally speaking, direct-current generators are better adapted for gas engine drive where parallel operation is required, and for many reasons the direct-current motor has characteristics that make it preferable for work, such as operating cranes, and absolutely necessary for service where a wide range of speed under the direct control of the operator is desired.

On the other hand, the alternating-current motor has its place, and owing to the simplicity and cheapness of the motor itself it is growing in popularity.

Now, you may be wondering what all this has to do with gas engines. Just this—there was a time when a gas engine could be properly questioned on its ability to drive alternating-current generators in parallel. With direct-current machines this is comparatively simple. All that is necessary is to be sure the engines will hold up their speed proportionately under load, adjust the voltage of the generators and throw them together.

With alternating current there is another limiting condition—the frequency—which, with the commercial standard of 60 cycles, means that there are 60 complete reversals of the current each second—something to be reckoned with. It means that for satisfactory operation in parallel the generators must not only have the same speed regulation, but must keep in step, as it were, and here is where the irregular impulse of the gas engine became a serious problem, which, for a long time, was difficult of solution; but I am happy to say, it has been solved through the cooperation of the electrical manufacturers and the gas engine builder. On the part of the gas engine it requires the multi-cylinder construction, which, with properly proportioned flywheel and correct governing mechanism, smooths out the angular fluctuations in the impulse transmitted to the generator shaft. The generator, too, must be so designed that it will tend to pull itself in step, which is accomplished by what are known as dampeners between or in the poles themselves. The action may be likened to 2 rubber gears meshing with pinions on a common shaft, the elasticity of the rubber tending to bring the generator back in step if there is an irregularity in the driving power.

In conclusion, the operation of generators by gas engine power is in every sense of the word a commercial success, and the prospective user of gas power can be assured of a satisfactory result.

ISOLATED PLANTS

WHAT THEY ARE ACCOMPLISHING IN LOW COST POWER GENERATION

By Rossiter Holbrook

I HAVE chosen to divide my talk into 4 headings.

1st—The illegitimate business of the central stations.

2nd—The comparative horsepower of central stations and isolated plants.

3rd—Is the isolated plant a paying investment, and

4th—Gas engines for isolated plants.

Before taking up the first subject in any way, I wish to emphasize the fact that I absolutely believe and I think most all of us, present, believe, that the central stations are a necessity. They have their field and should have the support of the community so long as they conscientiously try to please that field.

We are now having a very serious discussion in New York, before the Public Service Commission, regarding the discrimination in rates which we claim is being practiced by the New York Edison Co. I will not go into this matter in detail, but suffice it to say that they are selling current with a variation in rates of from 1½ cents to 10 cents per kilowatt hour, which discrimination is absolutely unfair in every sense of the word, especially when it is shown from their own reports in the Public Service Commission that they cannot manufacture and deliver current for less than 3¼ cents and make money.

I am going to take New York as an example and discuss the New York Edison Co.'s report to the Public Service Commission for the half year ending December, 1907. (I take this year because Mr. Moses, with whom I am associated, has figured this out, and the reports since then have had practically the same percentage.)

The total income for the 6 months was $7,231,602.62. The cost of producing this at the switchboard was $1,318,570.21, which is about 1/6 of the selling cost. The other 5/6 are made up of

Distribution	$1,210,108.84
General expenses	704,400.71
Amortization	916,024.11
Uncollectable bills	92,860.08
Taxes	402,943.21
	$3,325,336.95
Dividends	$2,586,695.46

Think for a moment. One-sixth of the cost to the consumer is the actual cost of manufacture.

Another point. Less than $917,000 is set aside for amortization. They actually wish to make the isolated plant owner figure 10 or 15 per cent for this, and then they figure 1 per cent semi-annually.

Still another point.

There were 120,000,000 kilowatt-hours delivered during these 6 months, which required over 687,000,000 lb. of coal or over 5½ lb. of coal per kilowatt-hour delivered, yet the smallest gas engine producer plant uses less than 2½ lb. of coal per kilowatt-hour.

I shall not continue these details further than to say that their labor cost was greater than a private plant's; their waste losses over 7 times as great; their repair and maintenance expense far greater.

They soak the little fellow so as to pay the losses they have incurred by selling to the big fellow, at less than the cost of manufacture and distribution. In doing this they are still more unfair because their discrimination is entirely based on quantitative use and not on the hours of service.

All of this goes to show that the central station is not fitted to compete with the isolated plant on the premises.

The Comparative Horsepower of Isolated Plants and Central Stations

A FRIEND once said to me, in all sincerity, "You know as well as I do that isolated plants are a thing of the past." I naturally felt a little touchy, but had no proof. A little while after this a member of one of the largest companies supplying the central stations with lamps, fans, and in fact all their necessities, asked us (I speak of Mr. Moses and myself collectively, as we are trying to be editors), "Have you any figures to show the comparative horsepower of central stations and isolated plants in the United States?" We had to say no, but we have started to collect this data.

We have covered Connecticut, Delaware, Indiana, Iowa, Kentucky, Maryland, Massachusetts, Michigan, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Wisconsin and Illinois—15 states in all, less than ⅓ the total number in the Union. In those 15 states there are 5,544,888 engine horsepower in isolated plants, and in the whole United States the total central station horsepower is (according to the census bureau) 4,862,921.

Why, in this one state of Ohio there is a good deal over 800,000 horsepower of isolated plants, and Cleveland has well over 390,000 horsepower of them.

Gentlemen, a small but interesting detail that has been brought to my attention is that of the 92 hotels in New York City, with 200 or more rooms, only 4 are without a private power plant. I am bringing all this data up in order that I may ask: "Are all these owners of isolated plants out of their heads?" To hear a central station man talk, one might think so.

Does it Pay

AND now we come to the question: "Is an isolated plant a paying proposition?" The central stations say not. I should very much like to know why the Commonwealth Edison Co. is operating the plant in the Majestic theater building, on Monroe street, Chicago. They bought this plant at a rather fancy figure, and if they had believed in their own talk, it would have been "junked;" but not so, for they are operating it. The same condition exists at Gunthers, the Fisher building, and the Chicago Title & Trust building. In all these cases, the landlord and tenants are getting bills from the Edison Co., who, in turn, are operating the landlords' own plant and making money on it. Why, gentlemen, the New York Edison Co. has installed a little isolated plant at its own coal yards, instead of using current from its mains. If the central station will do these things—well, I will leave the rest to your good sense.

I could stand here all night and describe isolated plants that I know about, and give the accounts, operating costs, including rent, interest, depreciation, and all the tommy-rot charges the central station wishes to put on them and then find that the cost of current was well below the cost from the central station. I have reports from all over the country, such as the Great Northern of Chicago, where the total operating expense for 1905 was over $64,000 as against less than $34,000 for 1907, when a plant was in operation, a saving of 48½ per cent; the Missouri Baptist Sanitarium of St. Louis, that saves $1000 a year out of a total operating expense of less than $5000; the Sohmer Building (an office building) of New York, 29 by 100 ft., 12 stories, with a yearly cost of $2761.25

for heat, light and power, including 120,000 kilowatt-hours of electricity delivered from the plant; the Langsdorf building, a loft building where the total operating cost for 1910, for light, heat and power, amounted to $7757.39, and the electric current alone from the Edison company would cost $8198.85, making a saving of $441.

And I have here a report made by Mailloux & Knox on the plant in R. H. Macy & Co.'s store, installed in 1902. I should be glad to show anyone this report. They have covered 7 years—1903 to 1910—and the cost of electricity is 1.52 cents per kilowatt-hour. I could continue indefinitely to show you plants that are making anywhere from 20 to 50 per cent profit on their investment.

Reliability

THIS brings us to the subject of gas engines and isolated plants. First, we will show how the talk about reliability is perfectly ridiculous. The central stations say they are unreliable. If so, why do they use them? There are over 60,000 horsepower of gas engines in central stations in the United States. Incidentally, there are 172 central station gas producer plants in England. Think of all the unreliable central stations there must be. The big San Francisco central stations are putting them in. "But," says your central station man, "these are big units and are, therefore, reliable." This is some more fallacious reasoning. These gas engine central stations are more in small units than in large, and they run all the way from 40 hp. up.

A typical example of a gas engine installation for central station work is right out here in the Hoopeston Gas and Electric Co., Hoopeston, Ill. Here is a single unit central station plant, containing a 280-hp. engine and 2 producers of 150 rated hp. each. Just think! they have been supplying a community and have no breakdown. How they would hold up their hands in horror if an isolated plant attempted to run without a reserve unit. Then there is the Everton Electric Light and Power Co. out in Deer River, Minnesota, with another single unit gas engine producer plant of 80 hp.

It is an odd coincidence, the way I happened to learn about this plant. I came across it in the Electrical Review for March 25 last. I first read an editorial in that number, headed "Competition with Isolated Gas Engine Plants," in which the editorial staff just cut themselves loose to tear a gas engine isolated plant to pieces, and before they got through, that plant might just as well have been down at the bottom of the ocean. The plant was a 3-unit installation of about 90 kw. capacity.

On turning over a few pages, I came across the description of the Everton plant, in which they had figured the cost of 1.62 cents per killowatt-hour with repairs of less than $100 for the year and the load varied from 15 to 80 hp. Can you "beat it"?

There are many more like it. I suppose the Cleveland company will say, "What have we to do with these central stations?" etc. Gentlemen, they have a great deal more to do with them than they like to tell about. Nearly all the central stations of the United States are banded together, forming the N. E. L. A., and you would be surprised at how the little fellows are watched by the big ones, so that as soon as they become worth while the large companies can gobble them up. This Association publishes a paper called the National Electric Light Association Bulletin. I have a copy of it here. In it they have a question box, and I shall read one or two questions.

"21-28. Would like to get from members data on heating different kinds of buildings, as we find this important in trying to shut down isolated plants. Please give length of heating season, kind of building, pounds of fuel per cubic foot of building for heating season, price of fuel per ton of 2240 lb., kind of heating system used and pressure required."

Do you now wonder why they have such plausible arguments?

Producer Gas Plant Costs

BEFORE taking up the natural gas side of the question, I am going to tell about a few of the producer gas plants that I have seen, and carefully watched the operation of for days at a time.

My first visit was at the small weaving mill of C. E. Hertlein, in New York City. The plant consisted of one 120-hp., 2-cylinder horizontal, single-acting engine (which was doing all the work), and one 2-cylinder vertical, single-acting engine of 120 hp., which was held in reserve. Furnishing fuel for these were 2 producers of 125 hp. and 150 hp., respectively. After taking a day's time in figuring every possible expense against that plant, I found it was operating for less than 1.35 cents per kilowatt-hour.

Another plant, that of Messrs. Stroebel & Crane, in Newark, N. J., a loft building, 4 stories high, 50 by 100 ft. The plant is a single unit gas engine producer plant, 100 hp. capacity. It has operated for 4.5 yr. 10 hr. a day, with one stop of 20 min. during operating hours. Charging everything up to the plant, including interest, depreciation and even the heating of the building by steam, the cost per kilowatt-hour is less than 2.1 cents.

Then there is the producer plant in the Acme Garage, on 32nd street, consisting of 2 75-hp. units, with charges of less than 0.8 cent per kilowatt-hour, including coal, oil, sundries and labor. Also the Perika Chocolate Co. in Brooklyn, with a 40-hp single unit producer plant, with a connected motor load of 60 hp. and operating cost, exclusive of fixed charges, amounting to the large sum of less than 0.6 cent per kilowatt-hour.

Then the 4-unit plant of the Swift Packing House, in the Bronx, consisting of 2 engines for generator service and 2 engines for ice machine work. This plant is selling current to the firm next door and the engineer of Swift's told me that they were making current so cheap, that he did not dare give me the figures because he was afraid their next door neighbors would think that Swift was cheating them.

The plant of the John Thompson Press Co., Long Island City, where there are 2 units of 125 and 65 hp. respectively.

I have very complete figures of operation for this plant and, incidentally, would say it emphasizes the fact that it is possible to bank the fire in a producer in such a manner that there is not nearly the fuel waste that there is in a steam boiler. This plant for one year only operated for 196 9-hr. days and had to stand by for the rest of the time, and yet the cost was 1.46 cents per kilowatt-hour.

There is also a plant at Royal-Aikens, in Ossining, a 40-hp. single unit plant, with a use of less than 1¾ lb. of coal per brake horsepower-hour.

Advantages of Isolated Plant Service

POWER cost per kilowatt-hour—usually less than ½ the best central station rates.

(2) Greater reliability of service, because the plant is located on the premises supplied and the building is not dependent upon power stations located a mile

or more away, with lines laid through streets subject to disturbance and with power house machinery operated under high voltage.

(3) Independence. Where an isolated plant is operated the building owner can fix the price at which he will sell current and the hours during which the current will be available; he can regulate the voltage to suit the conditions so that if he uses arc lamps he can run at 110 volts, and if he uses other kinds of lamps he can run at 120 volts, as he may see fit.

(4) Better maintenance of the building, because of freer use of electricity for lighting and other purposes.

(5) Reduced fire risk, because of availability of high-pressure power pumps at all times while the plant is operating.

(6) Less liability to accidents, because of the presence of competent mechanics on the premises at all times; also because of more careful inspections and more systematic operation.

(7) Increased renting facilities. With an isolated plant, a building owner can offer a prospective tenant a low rate for light and power, or, he can, if he wishes, include it in the rent, without excessive cost to himself, and in this way secure desirable tenants who might otherwise be lost.

(8) Electricity available for many purposes. Electricity costing less than 1 cent per additional kilowatt-hour is available for manufacturing, cooking, localized heating and power processes.

Investment Cost

THE question that seems to be the greatest sticker is the investment. And right here is where I want to get in on the central stations. They have a great habit—strange to say—of emphasizing the investment, the interest on the same, fixed charges, etc. I am going to ask you kindly to follow me through a bit of reasoning that seems to me to have good grounds. I am taking this argument from an article written by Mr. Freund, in the July, 1910, issue of the "Isolated Plant."

Mr. A. and Mr. B. have each erected a loft building identical in every respect, excepting that Mr. A. has decided to install a power plant for producing necessary heat, light and power, etc., while Mr. B. has decided to install a plant for purposes of heating and refrigerating only, purchasing all electric current for light and power from the public service corporation. We may assume that the requirements of both buildings are identical.

In order that we may use actual figures in the following discussion, I have followed closely those given on the Gretsch Building, Brooklyn, N. Y., in the April issue of The Isolated Plant.

Mr. A. installs his power plant at an initial cost of $13.900, which he borrows at 5 per cent interest, and his operating expenses for this plant are annually $3,700.

Mr. B. installs his heating plant at an initial cost of $8,000, which he borrows at 5 per cent interest, and his operating expenses are annually $1600. In addition to this he pays $4800 annually for electric current.

At the end of one year Messrs. A. and B compare notes on the cost of utilities and find as follows:

Mr. A.'s expense account:

Interest on loan	$ 695
Operating expenses	3,700
Total outlay	$4,395

Mr. B.'s expense account:

Interest on loan	$ 400
Operating expenses	1,600
Paid to Public Service Corporation	4,800
Total outlay	$6,800

Which means that Mr. B. has had to pay out approximately $2,400 more than Mr. A. Mr. B., however, refused to "be shown," and continues "in the error of his ways." Mr. A. decides to invest at 5 per cent the $2400 which he has saved and continues to do each year.

At the end of 20 years it becomes necessary for both Messrs. A. and B. to install new equipment. Says Mr. B., "We are back where we started." He is, but is Mr. A.? Let us see: We find that $1 saved each year, and invested at 5 per cent, would produce at the end of 5 years a sum of $5.50 approximately. Therefore, at the end of the fifth year Mr. A. has saved $2400 \times 5.50 = \$13,200$. Shortly after he repays his loan of $13,900. For the remaining 15 years his operating expenses are his sole outlay and he saves each year $3100 more than Mr. B. We find that at the end of 15 years this would amount to $3100 \times 21.50 = \$66,960$. How about Mr. B.? Oh, he must still repay his original $8000 loan.

To sum up, at the end of 20 years, Mr. A., who installed a power plant, has accumulated, because of such installation, $66,960. Mr. B., who decided to purchase current, still owes $8000. In other words, Mr. A. is $75,000 ahead of Mr. B. And the result due to additional original investment of $5900 to secure electrical equipment—1250 per cent in 20 years. Have I considered the cost of the plant? Yes; for I have paid off on a plant life of 20 years or 5 per cent depreciation. The preceding disposes of the question of fixed charges. Insurance and taxes need not be considered, for the difference, if any, is negligible.

Gentlemen, there is money and lots of it in isolated plants. There is a far greater degree of profit than in central stations, for central stations are, and should be, restricted by the public, because they use the public's property, and, besides, they have to supply a very large amount of unprofitable business. The central station is only allowed a certain amount of profit anyway, but the isolated plant business is unlimited.

At the present time, there is an operating company in New York City that is beginning the business of installing plants and operating them for profit.

I can cite you a very interesting case in a large office building on Fifth Avenue. This building was running on central station service, but it had high-pressure boilers installed. This operating company went to the owners of the building and, to make a long story short, the profit from the investment for the year just terminated was $10,873, on a total investment of less than $20,000.

There is the kind of company some of you gentlemen ought to form. The object of the company—to install and operate isolated plants for profit.

Now, in regard to the operation of plants: The way to avoid a high labor and repair cost is to have a supervising engineer. Say, there were fifteen plants that would each pay $20.00 a month, that would amount to $300.00 a month. For this you could hire a good, high-class engineer and an assistant. Their duty to be a general supervision of the plants which would allow of lower priced men in the plants themselves.

CENTRAL HEATING PLANT

By F. O. Kirby

BOILER house of the Central Heating Plant at Temple, Texas, for the G. C. & S. F. Ry., is located next to the round house, to allow the use of exhaust steam from the mechanical department, a Scotch-marine boiler of 200 hp. being the main generator. The plant was installed to take care of the radiation in all the buildings at this station. At present it is furnishing about 8000 sq. ft. of radiation, the depot and office building having 4800, and the store house 3200 sq. ft. Later, the plant will heat the new Harvey Hotel, the Railroad Y. M. C. A., the new freight depot, and furnish steam for heating and running machinery in the laundry.

Originally the company intended to heat each building with a separate plant. It was suggested that a central heating plant be installed capable of carrying the present and the future buildings.

After the work, as first installed, was torn out of the buildings, all connections were made to convert the in-

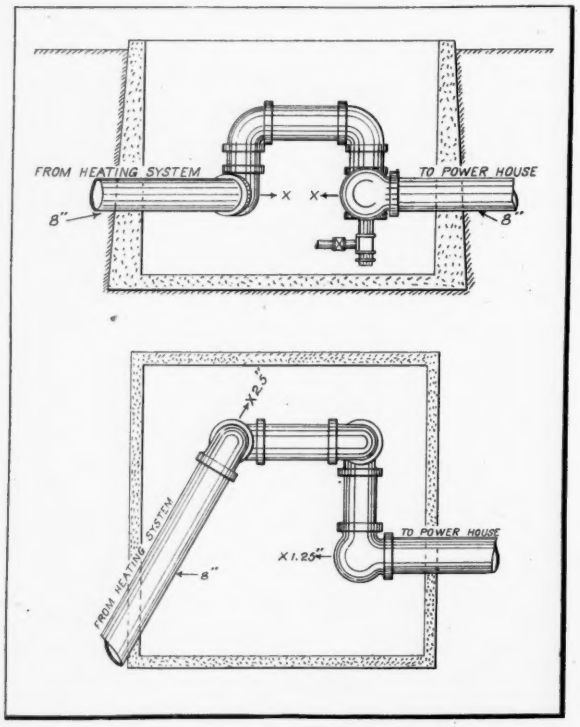


FIG. 1. ELEVATION AND PLAN OF PIT NO. 1

stallation in the buildings to a vacuum system. This old work was shown in a recent issue of the Practical Engineer. A ¾-in. line was run from each radiator to the return, and each radiator controlled by a water seal motor. All pipe connections to radiators were run above the floor line instead of running a stub under the floor. The line from the main in the attic to riser was made with a swing joint, where taken off the main and where the riser entered ceiling; all flange couplings were made in the attic or in accessible places. Pipe lines in the attic were covred with asbestos.

Outside of each building in pits Nos. 5 and 9, a Webster vacuum controller was installed so that the vacuum on the heating system in each building could be controlled as desired.

The boiler house contained in connection with the boiler, one 10 by 12 by 12-in. Marsh brass fitted vacuum pump, the suction line of which connects through a 3½-in. Webster suction strainer, so valved that the condensation is returned to the vacuum pump. The discharge, by gravity, is to a sump outside of the building. A 3-in.

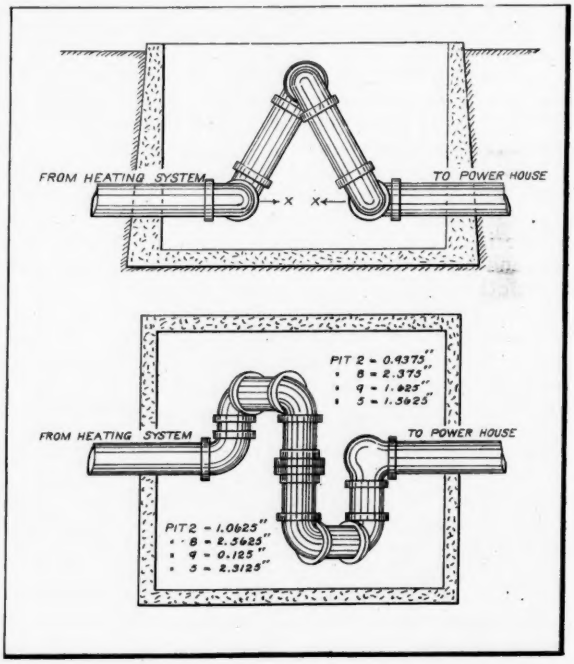


FIG. 2. ELEVATION AND PLAN OF PITS NOS. 2, 8, 5 AND 9

water discharge from the pump is connected to a No. 3 Webster class E B feed water heater, with seal and vented to the atmosphere. A Worthington 6 by 4 by 6-in. feed pump is provided for the water heater, and is arranged so that either boiler can be supplied with water.

Exhaust pipes from the mechanical department, the water service pump, vacuum pump and the boiler feed pump were connected to a 5-in. exhaust line with a connection made to the feed water heater, the oil separator being drained through a 1-in. Webster grease trap. On the inlet side of the separator was placed a gate valve with a by-pass connection made to atmosphere through a 5-in. Kieley single-seated back-pressure valve and a 5-in Kieley cast-iron exhaust head drained through a No. 1 Kieley low-pressure trap. On the gage board are 2 5½-in. compound gages A ¼-in. line from the heating main was run to one of these gages. A ¼-in. line was run from the main return through a suction strainer to the other gage, also a connection made from this line to the vacuum governors from the diaphram pressure reducing valve. A ½-in. controlling pipe was connected into the 8-in. low-pressure heating main.

From the boiler an 8-in. line was run, as shown in Fig. 7, to the 2 buildings. In the detail of the pits the return is not shown, neither are the controllers, receivers, water seal motors, valves, etc., nor the high-pressure line for the laundry and the coach heating line.

These pits were made of concrete, reinforced with ½-in. bars 12 in. on centers, on account of being so close to the tracks in the yard. They are covered with a concrete piece having a cast-iron manhole cover arranged to allow for inspection. Each pit was provided with a drain. The 2 controller pits are 8 by 8 by 8 ft., the others 6 by 6 by 8 ft. The pipe line was insulated with split tile conduit and mineral wool.

Owing to the fact that the company was anxious for steam in the new buildings and the new boiler was delayed in shipment, a switch engine was run on a siding next to the boiler house and connections made to the line from it. A cold water test was made on each line of pipe between pits as the work was installed. During the laying of pipe the average temperature was 80 deg., during the first test the average temperature during the day was 72 deg. The weather was slightly cloudy, wind S. S. E., steam was turned on at 2 p. m. Expansion at each pit was noted by the use of plumb line swung from the ceiling of each pit on both ends that pipe would travel, also by marker where pipe passed through concrete pit at wall. Not having a pressure reducing valve of small size, steam came direct from the switch engine, being turned on slowly, about a half turn on valve. The gage registered 100 lb. at the boiler. The expansion of pipe at the different pits will be noted in the drawings, the points of expansion being indicated by X.

Steam was cut off after being on about one hour and a half to make some minor repairs and was not turned on till 11 a. m. next morning; reading on the pipe lines on contraction showed that most all joints had returned to their original places. At pit No. 1, on the line from the heating system it failed to come back to the original point, 0.18750 in. At pit No. 2, it was over original point 0.25 in. to power house. At No. 3, less original point on power house line of 0.031230 in., and on line from heating system, plus 0.3750 in. At No. 6, from heating system, a plus of 0.2500 in. At No. 7, a minus of 0.1870 in. on power house line. At No. 9, on power house

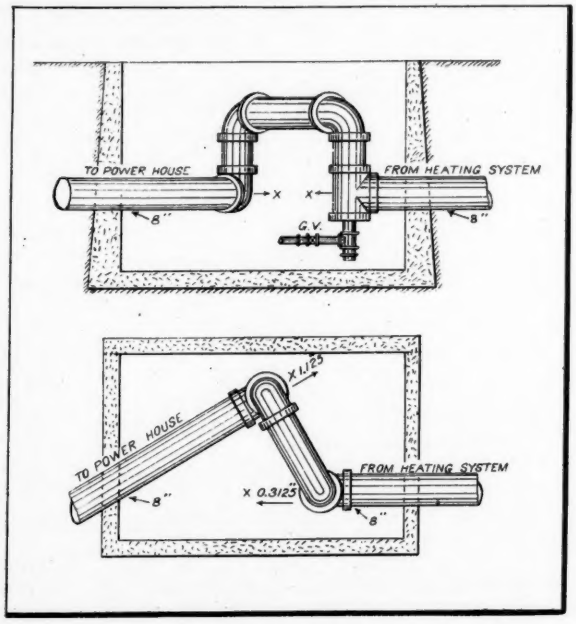


FIG. 3. ELEVATION AND PLAN OF PIT NO. 3

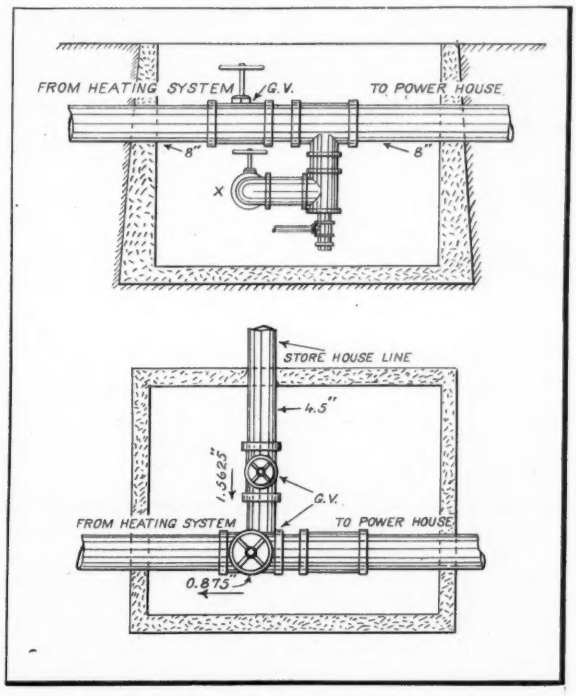


FIG. 4. ELEVATION AND PLAN OF PIT NO. 4

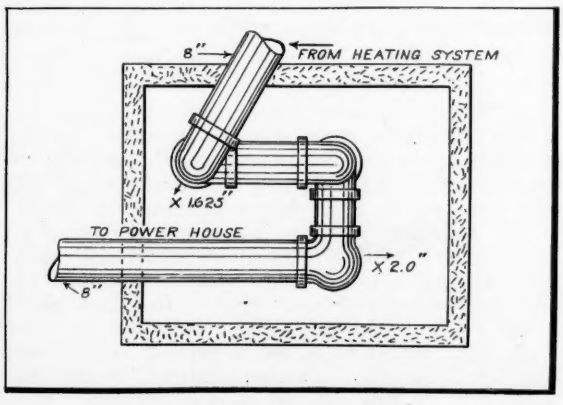


FIG. 5. PLAN OF PIT NO. 6

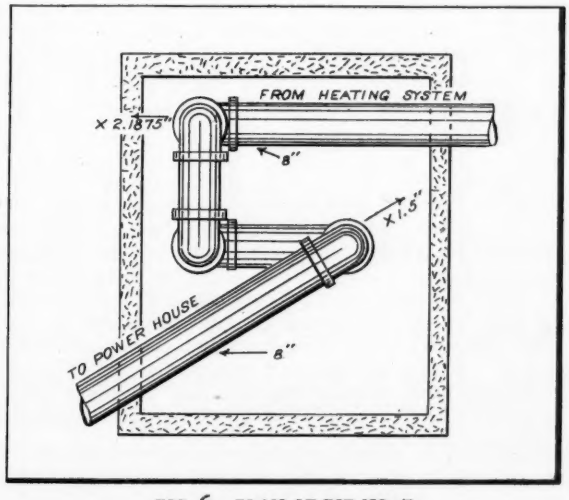


FIG. 6. PLAN OF PIT NO. 7

line, a minus of 0.43750 in. All the other pits to their original points.

After the new boiler was installed and all other apparatus in the boiler house the new plant was again tested. At 5 lb. gage pressure, the expansion was practically the same. At pit No. 1, on heating system line, 2.3750-in.; at pit No. 5, on power house line; 2.1875-in. At No. 8 on power house line, 2.3125-in.; on heating system line, 2.53125 in. All the others remained the same as first test. All these measurements were carefully checked, as I wished some data on expansion of pipe under different conditions.

The test of this plant was on for about 10 days before it began to work without any trouble. The line was clear

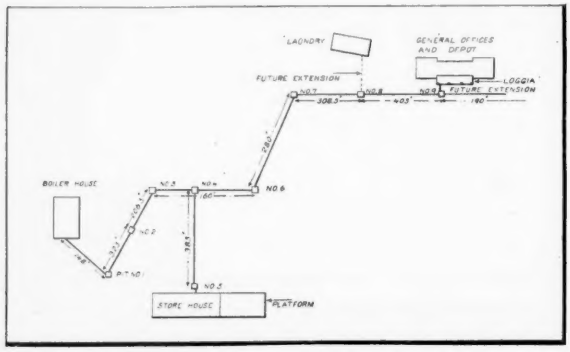


FIG. 7. LAY OUT OF CENTRAL HEATING PLANT

then of all dirt, filings, etc., the strainer at the pump being cleaned about every 3 days and only a small amount of material collected. This pump was connected so as to drain the condensation from the main, the return and the high-pressure line, and of course received more refuse than it would if only on the main and return. On account of not having a competent fireman in charge of the plant, we had trouble 2 or 3 times from cutting off the pump and letting the system fill with water, or he would run his pump and let the steam die down. The plant was turned over to the company March 20, 1911, in good working order. A good circulation of steam, the pump holding 26 in. of vacuum at the boiler house and from 4 to 6 in. at the controller pits. During the last of March sufficient heat was furnished from the exhaust and about one pound of steam. The plant was installed by Collins Bros. Co., Houston and Dallas, Texas, from plans of the Warren Webster Co.

PRODUCTION OF GOLD in 1910 amounted to $96,055,214. The total building construction in Chicago in 1910, including new buildings, additions and alterations, amounted to $96,932,700. The sum of these 2 figures lacks more than $22,000,000 of the actual destruction by fire in the United States of buildings and contents during 1910. Careful observation of the operation of automatic sprinklers leads to the inevitable conclusion that at least half of the $214,003,300 which went up in smoke could have been saved if the principal buildings which burned had been adequately protected by this form of fire prevention apparatus.

NEW ENGLAND ASSOCIATION of Commercial Engineers is arranging for a Power Show, April 22-27, 1912, in the Mechanics Building, Boston. This will be held in conjunction with the Textile Exhibition, and will include exhibits of all kinds of power machinery and supplies. Full information can be had by applying to E. F. de Gruchy, 12 Pearl St., Boston, Mass.

THE VALUE OF EXHAUST STEAM IN ISOLATED PLANTS

BY CHARLES L. HUBBARD

IN making a comparison between the cost of power as generated by an isolated plant or a central station, the utilization of exhaust steam must always be considered. Except in special instances, the engines in central stations are run condensing, and no use made of the exhaust except for feed-water heating; and these conditions will be assumed throughout the present article. Furthermore, the term "isolated plant" is taken as applying to cases where steam is required for purposes other than feed-water heating, for at least a portion of the year, as in office buildings, institutions, factories, etc., where heating and ventilating plants are operated during the winter months.

Advantages of Isolated Plant

IT seems to be a generally accepted fact among engineers that the isolated plant has the advantage in point of economy over the purchase of light and power from a central station, when the exhaust can be utilized for heating purposes during a considerable portion of the year. There are, of course, exceptions to this, but the large number of power and lighting plants installed in buildings of the class above noted, is a practical proof that experience has shown them to be a desirable investment.

The boiler plant and its auxiliary equipment must be installed in any case for heating purposes, and in a majority of buildings the necessary increase for power purposes is comparatively small.

There are various reasons for the greater economy of the isolated plant, among which are the utilization of the exhaust from the engines; less expensive equipment, and therefore smaller interest and depreciation charges per unit of power; a reduction in transmission losses; and finally the elimination of profit to the central plant. The mistake is sometimes made of considering the utilization of the exhaust as the only saving. While this is an item of much importance, the others mentioned will sometimes overbalance this.

There may be cases, even when less fuel is required for generating the power at a central station, throwing away the exhaust, and heating from a private plant at the building, that it will prove advantageous to install an isolated plant for both power and heating.

Value of Low Water-Rate

ASSUMING the isolated plant to be generally more desirable for the class of buildings under consideration, let us now confine ourselves to the varying conditions to be found here, and the best type of equipment necessary to meet these conditions.

The statement is often made that the water-rate of an engine is of little importance where the exhaust is to be turned into a heating system, as it is all usefully employed ultimately. This is true to a certain extent, but not wholly so. The fact that an engine has a high water-rate is due largely to cylinder condensation, although low ratios of expansion and leaky valves add to this. Water of condensation thrown out with the exhaust has no value for heating purposes under existing conditions, and if it were not for re-evaporation as it passes at a high temperature into the lower pressure of the heating system, there would be but little more steam available for heating than with a more economical type of engine. The simple

noncondensing engine, which is the most wasteful type, has a low ratio of expansion, and exhausts at a comparatively high terminal pressure; hence, re-evaporation is greater than with a compound engine; for example, where expansion is carried to a greater degree and the terminal or exhaust pressure is lower.

Under ordinary working conditions only about 3 lb. of steam per horsepower per hour are required for the work actually done by the engine, the remainder passing out in the form of exhaust steam and water. This is practically true whether the engine is using 15 lb. of steam per horsepower or twice that. With a low water-rate the percentage of steam used in doing work is comparatively large, cylinder condensation small, and re-evaporation after exhaust small. With an engine having a high water-rate, these conditions are reversed, so that the net result remains approximately the same. That is, whatever the water-rate of the engine, the percentage of steam in the form of exhaust will be practically the same in each case.

For average conditions this may be taken as about 80 per cent. For example, if an engine uses 3000 lb. of steam an hour, there will be 3000×0.80=2400 lb. of exhaust available for heating purposes.

Utilizing the Exhaust

NEXT let us see how the fuel requirements are affected by utilizing the exhaust under different conditions. First take the case of a 100-hp. simple noncondensing engine using 30 lb. of steam an hour per i. hp., and assume that 9000 heat units are utilized in the boilers from each pound of coal burned, which corresponds with average practice in the case of water-tube boilers.

Boiler pressure 90 lb. per square inch, gage; initial temperature of feed water, 50 deg.; temperature of steam at 90 lb., 331 deg.; latent heat of evaporation, 881 t. u.; heat required to raise temperature of 1 lb. of feed water from 50 deg. and evaporate it into steam at 90 lb. (331—50)+881=1162 t.u.

Steam used per hour by engine, 100×30=3000 lb. Fuel required per hour, 3000×1162÷9000=387 lb. Now let the exhaust be discharged into a heating system operating under atmospheric pressure, and charge the fuel equivalent to the heating account.

Weight of exhaust steam, 3000×0.80=2400 lb. Latent heat at atmospheric pressure 966 t.u. Fuel equivalent, 2400×966÷9000=257 lb. Fuel for power alone 387—257=130 lb. per hour. Another matter to be taken into consideration at this point is the reduction in boiler power. In the first case the exhaust was thrown away and the heating done with live steam. In the second case 2400×966=2,318,400 t.u. per hour are available in the exhaust, hence 2,318,400 ÷33,000=70 boiler horsepower less are required when the exhaust is used for heating.

Central Plant Comparison

LET us now compare the above figures with a central plant, using 13 lb. of steam per i. hp. per hour at 155 lb. pressure, and turning the entire exhaust into a condenser; the feed water being heated by exhaust steam from the auxiliaries. Initial temperature of feed water the same as before, 50 deg.

Temperature of steam at 155 lb., 368 deg. Latent heat, 854 t.u. Heat required to heat and evaporate 1 lb. of water into steam, (368—50)+854=1172 t.u. Taking 100 hp. as a basis of comparison, we have: Steam used per hour, 100×13=1300 lb. Fuel required, 1300 ×1172÷9000=170 lb. This gives a difference of 170—130=40 lb. of fuel per hour in favor of the isolated plant, provided the exhaust can be utilized the year around. As this is not the case, except in special instances, it would be necessary to know the rates charged by the central station and the proportion of exhaust which could be used during the entire year before making an accurate comparison.

Use of Engine With High Efficiency

IT might be well in a case of this kind to use a more economical engine in the isolated plant; say a 4-valve compound engine, having a water-rate of about 24 lb. per i. hp. per hour. In fact, this type of engine is coming into use quite extensively for this class of work on account of its greater economy during the summer months, when the exhaust must be thrown away, except for feed-water heating.

Let us take an engine of this type, using 24 lb. of steam per i. hp. per hour at a pressure of 130 lb., and see how it compares in economy with those just examined.

Initial temperature of feed water, 50 deg. Temperature of steam at 130 lb., 355 deg. Latent heat of evaporation, 863 t.u. Heat required per pound of steam, (355—50)+863=1168 t.u. Steam used per hour by engine, 100×24=2400 lb. Fuel required per hour, 2400×1168÷9000=300 lb. Now exhausting into the heating system at atmospheric pressure as before, the saving on fuel equivalent is found to be 2400×0.80 ÷9000=206 lb., which makes the fuel rate for power alone, 300—206=94 lb. per hour. This, compared with the central plant, gives a fuel difference of 170—94=76 lb. per 100 hp. per hour in favor of the isolated plant when utilizing the exhaust steam.

By installing a condenser in the smaller plant, the fuel consumption could be brought down to about 300×0.80=240 lb. per hour, or a balance of 240—170= 70 lb. in favor of the central plant during the summer season. This condition makes the fuel rate per i. hp. about equal in the 2 plants when the whole year is taken into consideration, and the advantage of the isolated plant would be based upon the other factors before mentioned.

IRON IN WATER

A HALF part per million of iron in water is detectable by taste and more than 4 or 5 parts make a water unpalatable. In some mineral springs iron is the constituent which imparts a medicinal value to the water, but ordinarily it is undesirable. More than 2.5 parts per million in water used for laundering makes a stain on clothes. Iron must be removed from water from which ice is made or a cloudy discolored product will result. An iron content of over 2 or 3 parts per million in water used in the manufacture of paper will stain the paper.

Iron is harmful in water used for steaming, for it is in equilibrium with acids which inside the boiler become disassociated, with the result that the free acids corrode the boiler plates; but the amount of iron carried in solution by most waters is so small that the damage it does to steam boilers generally amounts to little.

Waters having high iron content have in some places caused an immense amount of trouble and expense when used as city supplies, for they favor the growth of Crenothrix to such a degree that the water pipes become clogged with the iron sheaths of the organism.—Water Supply Paper 273, U. S. Geological Survey.

POWER PLANT RECORDS

MAKING A START

By G. F. Gebhardt

THE WRITER WAS AGREEABLY surprised at the number of communications received from owners and operators of power plants, relative to his article on Keeping and Analyzing Records. All agreed that a properly maintained system of records and cost accounting was essential to high operating efficiency and that harmonious co-operation of the office and power plant forces was necessary to effect this result, but they were also of the opinion that such a successful climax would only be realized in the millenium.

The owners insinuated that the average operating engineer took no interest in the financial side of the plant operation and was incapable of maintaining a system of records even if provided with the necessary equipment; the operating engineer, on the other hand, accused the owner of extreme parsimony in connection with the plant equipment and of marked aloofness in business relationship. No better proof of the discord between owner and operator is necessary than these conflicting statements. So long as neither side is willing to be conciliatory, so long will the situation remain as it is.

The comparatively low rating of the profession of operating engineering, for it is no longer a "job," but a profession of high order, is largely traditional and accounts to a considerable extent for the owner's suspicion of the operator's capabilities. Not so many years ago any man strong enough to handle a shovel had the necessary qualifications for a fireman and any one who could keep an engine running was considered an engineer. The wages were so low that the ambitious and capable man could not be induced to take up this work, and as a result the operating engineer was not representative of the highest order of intelligence.

Development of the art, however, has been so marked that the modern operating engineer must be an Engineer in every sense of the word to hold his own successfully. His reputation, unfortunately, has not kept pace with his own progress. Evidently it is up to the engineer to convince the owner that he is no longer a laborer, but a department manager and deserving of all the consideration involved in the management of that department. But how shall he do this?

Let us take the extreme case in which the office and the power plant are completely divorced from each other. Suppose that the engineer is never informed as to the cost of coal, oil, packing, waste or any other article entering into the operation of the plant and he is never consulted in any way. Suppose the plant is equipped with only such measuring instruments as are absolutely necessary for safe operation. What is he going to do? What sort of records can he keep under such conditions? How can he acquire sufficient data to give him entrance to the office?

First Record to Keep

THE problem is not a simple one and a comprehensive set of records is manifestly impossible, but it is surprising how much can be done even in this extreme case. In the first place accurate figures can not be obtained, the results must necessarily be approximate, the degree of accuracy depending upon the frequency with which readings are taken and the method of making measurements. Printed and ruled log forms are out of the question on account of the expense. A cheap notebook and a pad of common paper will furnish the necessary writing material for a month's operation. The note book should be treated as a day book and all items entering into the operation of the plant should be recorded thus:

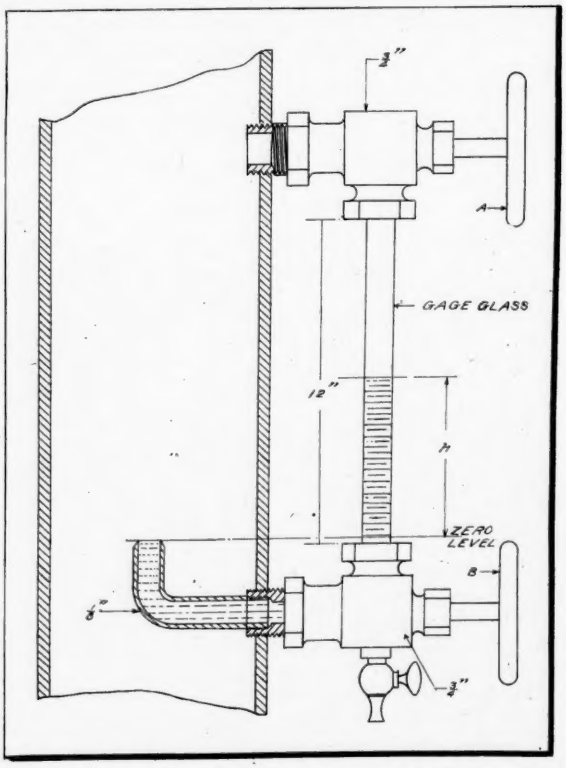


FIG. I. APPROXIMATE STEAM METER FOR VERTICAL PIPE

Dec. 2, 1911, Received 10 tons of coal.
" Received one barrel of cylinder oil.
" Packed feed pump (4 hours, J. Smith; No. 2, 2-in. packing).
" Replaced 10, 16-c. p. lamps in building.

and so on;

At the end of the day or shift, the total quantities for that period should be entered:

Dec. 2, 1911, Coal burned, 4250 lb.
" Water evaporated, 28,000 lb.
" Packing, 2 lb.
" Refuse removed, 550 lb.
" Cylinder oil, 1.5 gal.
" Dynamo oil, 0.8 gal.
" Average feed water temperature, 190 deg. F.
" Average output, 850 kw.-hr.

and so on;

At the end of the month the various items may be summed up something as follows, the exact distribution depending upon the size and character of the plant.

1. Supplies; Month of December, 1911.

Supplies:			
Engine Room	Quantity	Cost*	
Oil,	40 gal.	26.00	
Waste,	50 lb.	2.50	
Packing,	5 lb.	5.00	
Lamps,	35, 16-c. p.	6.30	
Miscellaneous,		10.50	
			$ 50.30
Boiler Room;			
Coal,	60 long tons	180.00	
Water,	105,000 gal.	46.00	
Miscellaneous		18.00	
			$244.00
		Total	294.30

(*) If these figures are not given to the engineer by the Purchasing Agent he must necessarily omit them unless he has other means of obtaining them, but leave the column heading as a suggestion to the owner when he sees the report.

2. Labor; Month of December, 1911.

Labor:		
Engine Room;		
Engineer,	90.00	
Boiler Room;		
Fireman	60.00	
Ash Handling	5.00	
Miscellaneous		
	Total	$155.00

A similar blank (3) may be filled out for repairs.

4. General Summary, Month of December.

Supplies	294.00	Water evaporated, 105,000 gal.	
Wages	155.00		
Repairs	15.60	Apparent evaporation per lb. of coal as fired, 6.5 lb.	
Total	464.60	Output, kw.-hr., 22,000.	
Feed temp. 190 deg. F.		Coal per kw.-hr., 6.1 lb.	
Boiler pressure 90 lb. per sq. in.		Operating cost per kw.-hr., 2.11 cents.	
Voltage, 110.		Rated Capacity of Generator, kw.-hr., 66,000.	
Av. Current, 240 amps.		Curve Load Factor 30 per cent.	
		Yearly load factor, 15 per cent.	

A great many more items may be suggested in the general summary but unless the engineer has had previous experience in entering data he will find a more comprehensive system altogether too burdensome.

In connection with the data outlined above the query naturally arises, how are we to determine the evaporation, power output and the like, without suitable recording instruments? This problem confronts nearly all operating engineers in charge of small plants and is the chief obstacle to the determination of the unit cost of power.

Taking the Measurements

FOR steam-electric plants, the electrical output may be closely approximated by taking frequent readings of the ammeter and voltmeter and averaging the results. When the electrical load is fairly constant or the average daily loads are practically the same satisfactory results may be obtained by repeating the operation once a week, but if the load is constantly changing, daily readings at frequent intervals are necessary for even approximate results.

For nonelectrical loads recourse must be had to the steam engine indicator and the average load approximated from a large number of cards. The time involved is considerable and the work becomes exceedingly irksome, but since there is no other solution of the problem this method must be adopted or the item of power distribution left out of the records. The position of the governor drop rod of a Corliss engine is an index of the output and many engineers approximate the power by graduating the movement of the rod in terms of the indicated horsepower. By taking frequent readings of this index the labor of indicating the engine may be dispensed with.

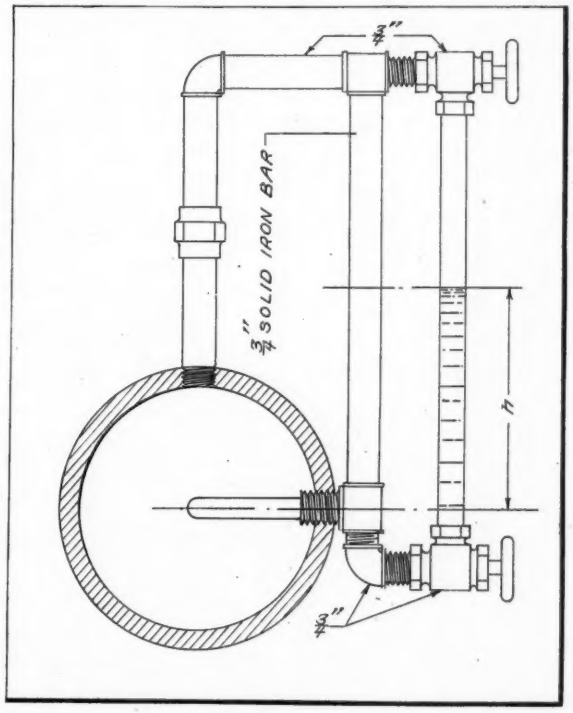


FIG. 2. STEAM METER FOR USE ON HORIZONTAL PIPE

Another way of approximating the steam consumption is to rig up an indicating steam meter out of pipe fittings as shown in Figs. 1 and 2. For vertical pipe arrange as in Fig 1. For horizontal pipes connect as in Fig. 2. The best results are obtained from the vertical arrangement. Throttle A and B so that water in the gage does not fluctuate violently. Be careful not to throttle too much or height will not correspond to the velocity pressure. The weight of steam flowing may be approximated from the height of water in the gage glass, as follows.

Measure the height h in inches above zero level (the level when no steam is flowing) and extract the square root; multiply this by 450 and by a coefficient k from the table herewith.*

Measurement of the water supplied to the boiler without the use of water meters is an annoying prob-

*As a formula;
$w = 450k\sqrt{h}$
w=weight of steam flowing, pounds per hour.
k=coefficient from the table.
h=height of water in the glass above zero level, inches.

lem. It is manifestly impracticable to install a system of tanks and scales and weigh the water directly. A simple and fairly accurate means of approximating the weight of water fed to the boiler is to fit up an indicating water meter as illustrated in Fig. 3. The apparatus consists essentially of a throttling disk (with diameter of orifice about ⅔ that of the feed pipe) inserted in the pipe line between the feed pump and boiler, and an indicating mercury manometer.

VALUES OF K.

Steam Pressure Lb. per sq. in. gage.	Diameter of Pipe, in.; Standard Thickness.							
	3	3.5	4	4.5	5	6	8	10
80	3.44	4.60	5.90	7.30	9.30	13.4	23.2	36.7
90	3.58	4.80	6.15	7.75	9.70	14.0	24.2	38.3
100	3.73	5.00	6.40	8.05	10.0	14.6	25.2	40.0
110	3.90	5.23	6.67	8.42	10.5	15.2	26.3	41.6
120	4.06	5.45	6.96	8.78	11.0	15.9	27.4	43.5
130	4.17	5.60	7.15	9.00	11.3	16.3	28.2	44.6

The scale on the manometer may be calibrated to read directly the weight of flow corresponding to different heights of the mercury column. This is accomplished by discharging the feed water into a weighing tank, at different rates of flow and noting the displacement of the mercury column. Correction for temperature may be readily made if it is not feasible to use water at the ordinary operating temperature during the calibration test. Readings taken at frequent intervals afford a means of obtaining the

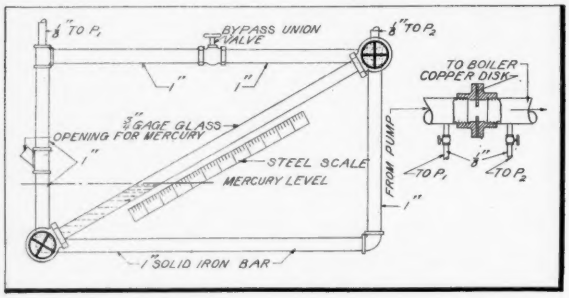


FIG. 3. SIMPLE MERCURY INDICATOR FOR MEASURING WEIGHT OF WATER FED TO BOILER

average rate of flow. The small pipes leading to the manometer must be freed from air before the calibration test is made. If there are a number of fittings between the boiler and feed pump the throttling disk may be omitted and the pressure drop measured across the fittings. The disk, however, gives more consistent results.

Determination of the weight of coal burned and refuse removed must be worked out by the engineer to meet the plant conditions.

The temperature of the feed water may be obtained from a thermometer inserted in the line close to the boiler. A satisfactory instrument with graduations etched on the stem may be purchased for 75 cents. If the line cannot be cut for the introduction of a thermometer cup, the only recourse is to press the bulb of the instrument against the bare pipe and imbed it in asbestos paste or other insulating material. The reading in the latter case is apt to be several degrees lower than the actual temperature of the feed water.

A fairly accurate mercurial thermometer reading up to 650 deg. F. may be purchased for $1, so that measurement of the flue gas temperatures need not entail any particular expense.

If neither thermometers or platform scales are available and the few pipe fittings for constructing the water and steam meters cannot be had, no records worth mentioning can be recorded.

A comparison of the monthly summaries will show whether improvement or loss in economy is effected, and will enable the engineer to locate the cause. In order to compare the performance of the plant with that of similar installations it will be necessary for the engineer to keep in touch with current practice. To do this he should subscribe for one or more of the leading trade journals and if possible take active interest in some local engineering organization.

It will require considerable time to keep up a satisfactory system of records but the time spent will be well repaid. One thing is certain, a beginning must be made, no matter how crude the initial results, if the plant owner is to be convinced that the operating engineer is sincere in his efforts to manage the plant scientifically.

Try it!

FURNACE BUILDING*

POINTERS ON SECURING DURABILITY AND ECONOMY

By Frederick L. Ray

IN the conventional arrangement of setting for a return tubular boiler, the side walls should be lined with fire brick of best quality from front to bridge wall, and a second grade of fire brick should be used on other parts of the walls, with all fire brick well tied into the red brick of the outer walls. The bridge wall should be only high enough to mix the gases thoroughly, and bring them close to the shell, the area between wall and shell being not less than the area of

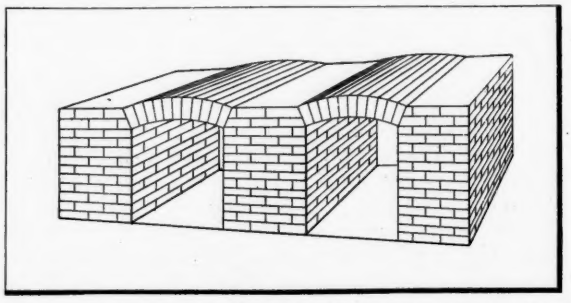


FIG. 1. BRICK ARCH CONSTRUCTION AROUND FIRING DOORS

the tubes, yet not less than 10 in. should be left between the wall and the shell. The bridge wall must be of the best fire brick.

Space behind the bridge wall is sometimes filled in and paved sloping toward the rear of the boiler, but the writer would always leave this space open to provide larger combustion chamber, and a receptacle for fine ashes. The ash pit should be paved and made water tight, so that it can be kept cool by spraying the ashes with water. A space of not less than 26 to 30 in. should be allowed at the rear of the boiler in order to give room for making repairs. On top, the boiler should be covered with a good nonconductor of heat about 2 in. thick, and on top of this a layer of common brick set on edge, forming a first-class insulation and protection. It is a good plan to leave a joint on the rear end between the inside and

*Abstract of an address before the Louisville Association of Stationary Engineers.

outside walls to provide for expansion and contraction, thus avoiding cracks in the brick work.

Trouble which is frequently serious is the falling out of brick about the doors where the construction is as shown in Fig. 1. A better plan is to use a special fire brick for this purpose, molded so that one or at least 2 brick will span the door, as shown in Fig. 2. Use as little fire clay as possible between the brick, as the fire clay will shrink considerably in drying and, if a thick joint be made, a loose wall will be the result. A little salt mixed with the clay will add to the strength and life of the wall. For laying the red brick in the furnace walls, use lime mortar and com-

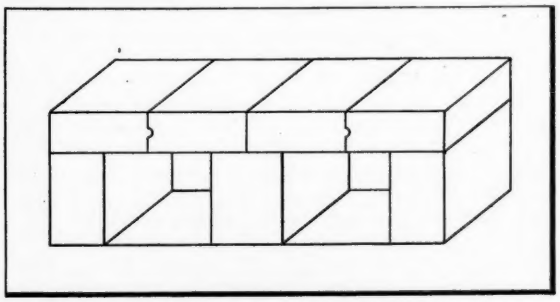


FIG 2. MOULDED BRICK ARCH FOR FIRING DOORS

mon cement. The lime mortar should be at least 1 week old when used and the last 12 in. of the wall should be laid in Portland cement mortar to insure a wall that will not be easily knocked down.

In the best practice the weight of the boiler is not carried on the wall, but some method of suspension on a steel frame is used.

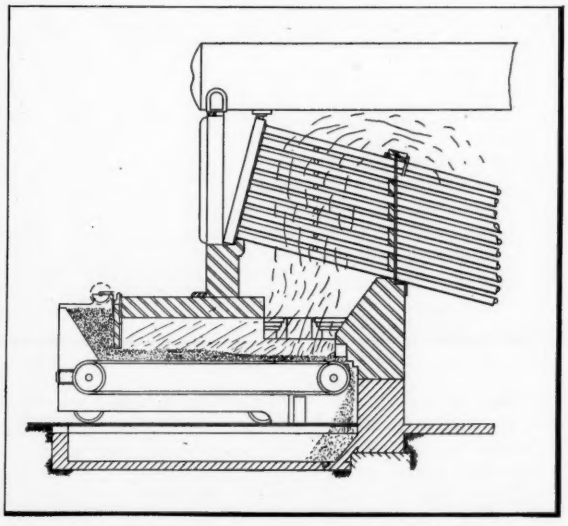


FIG. 3. B. & W. BOILER WITH CHAIN GRATE STOKER

Where there are doors through the brick work for inspection or cleaning, there are liable to be air leaks between the flanges of the doors and the brick. One of the best ways to make these tight, is to loosen up on the bolts and move the flange out; fill in with a good calking of plastic asbestos well wet. If the flanges are pressed up tight, there will be little chance for air leaks.

Great care should be taken to prevent water falling on any part of the brick work, as it is one of the most harmful agents, especially in the case of a fire brick arch.

In the case of a Babcock & Wilcox boiler with chain grate stoker, shown in Fig. 3, there is a wide fire brick arch which has but little spring, and in this case the arch must be built carefully and of best quality of brick, or it will not stay up well.

One of the most difficult problems in the operation of the chain stoker is to prevent air leaks past the tail of the grate. The remedy lies in so constructing the brick work that there will be no use for a damper, that is the ashes and clinker will themselves form the barrier against air leaks. The wrought-iron damper rusts and burns out quickly, so that it soon becomes inoperative.

In the setting for the Stirling boiler with hand-fired furnace, shown in Fig. 4, the fire brick arch must be built of select material by expert workmen. Even more brick work is required if a chain grate stoker is used, and the arch is important in securing complete combustion, but it has little spring and must, therefore, be given careful attention.

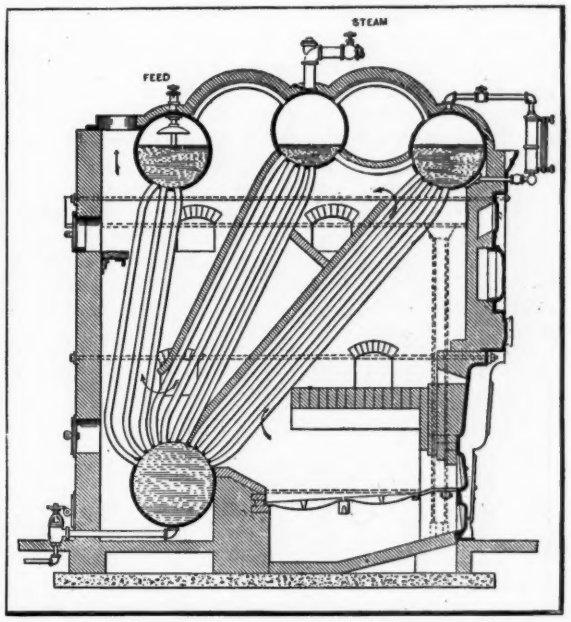


FIG. 4. STIRLING BOILER WITH HAND-FIRED FURNACE

Some things to be remembered about boiler furnace construction are: A good foundation is absolutely necessary.

Keep the weight of the boiler off the brick work if possible.

If weight must rest on the brick work, have but 2 supports on each side, and have the bearing plates on the wall large with rollers between the lugs and plates on the rear lugs only.

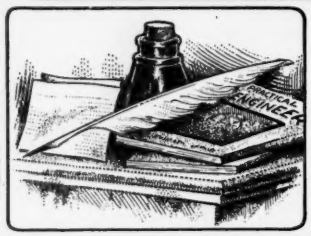
Provision should be made for expansion and contraction, so that the brick work will not be broken.

All brick work must be properly stayed, otherwise every time it is heated or cooled it will be driven away from the boiler, permitting foreign matter to work in between the boiler and the brick work.

Walls must be built as solid as possible, so as to exclude all air from the furnace.

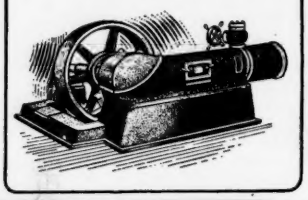
Red brick should be a hard, close grained material that will not admit air.

The quality of fire brick used depends on the kind of furnace and the position of the brick, but where brick is close to the fire the best is the cheapest.



Letters from Engineers

Bright Ideas direct from the plant. Send us yours. Cash paid for those accepted. Sketches desirable; we make the drawings



VACUUM BREAKER

I HAVE read of several cases of broken cylinders, beds, pistons, etc., caused by water getting into low-pressure cylinder due to the vacuum not being destroyed when steam was shut off, which allowed water to come in from the condenser. This caused a broken cylinder, piston and main bearing of a 1500-hp. Corliss engine only a month old, the water entering when the engine was being shut down for about 3 minutes; the damage was done when starting up.

This induced me to devise something which would act independently of the engineer when shutting down. The accompanying sketches of the device show its extreme simplicity and cheapness. It is adaptable to any condensing engine, and I have worked one for 2 yr. with the greatest satisfaction.

From the upper part of the condenser or the exhaust line a 2-in. pipe is run to a point near the governor. The end of the pipe is filed up square so as to make an air-tight fit with a rubber pad placed on an iron disk which is attached to the weight lever. The lever works on a pivot or bearing arranged as shown in the sketch and is held in position by a rod which fits in the knockoff hook, the suction of the vacuum in the condenser also aids in holding the rubber disk in place. An adjustable weight is so placed that it just lifts the disk when the knockoff hook is operated.

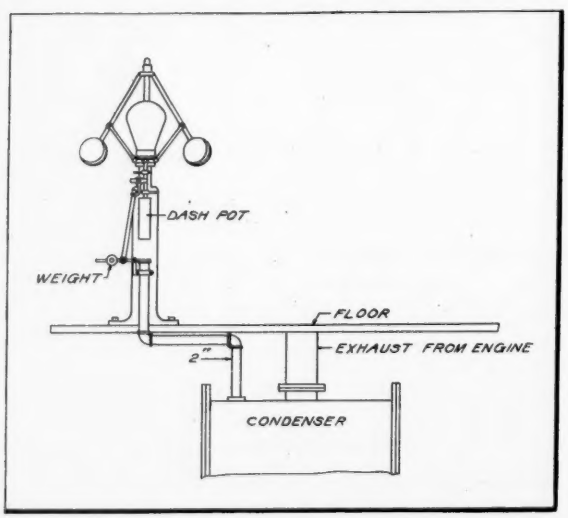


FIG. 1. VACUUM BREAKER CONNECTIONS TO CONDENSER AND GOVERNOR

On the governor rod to the dashpot are placed 2 knockoff levers which can be adjusted to break the vacuum at any desired high and low speed. These levers engage pins on the knockoff hook, thus allowing the weight to drop and the vacuum line to open relieving the condenser. Richard Howarth.

COOLING HOT BEARINGS

SEVERAL weeks ago I was called on to take the railway load in our plant where we have 2 800-hp. gas engines, as an auxiliary to the hydro-electric plant. The engines were being overhauled and were not in very good shape for running, but we started all safely.

After running a while, No. 2 engine's left-hand main bearing ran hot, and I used everything that I could think of in the way of dopes, but nothing seemed to cure it. I cut the load off several times, running the engine slow, and the bearing would cool down, but as soon as the load was put back on the bearings it would run hot again.

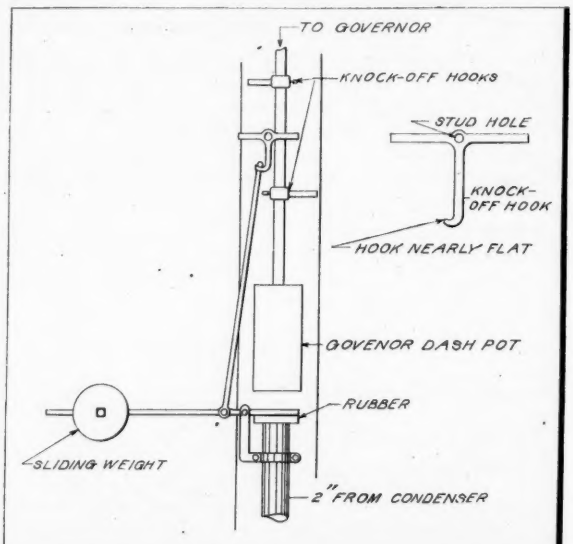


FIG. 2. DETAILS OF VACUUM BREAKER

I then slowed the engine down as much as possible, and began to key up on the bearing a little bit at a time until it was pretty tight, keeping a good stream of cylinder oil and flake graphite running on it all the time. After letting the engine run for a few minutes, I slacked off, speeded up and gave her the load, and that was the last of that bearing running hot.

In the mean time the right-hand bearing ran hot, and I immediately used the same method on it, and it proved successful. As soon as I began to tighten up on the bearings, the shaft began to brighten up and take oil, so that evidently the shaft had gotten a little rusty from standing so long, and by pulling up on the bearing it smoothed up both the shaft and the bearings. J. D. Linker.

LICENSE INJUSTICE

ON page 752 of November, 1911, Practical Engineer, I notice an article by Richard Howarth which I read with much interest. He refers to one on the same subject by J. W. Nash.

All laws are supposed to be made for the greatest good to the greatest number. We will first note the good the license law has done.

In the first place, license law set a standard of knowledge that an engineer must acquire in order to obtain a license. The engineers found they must study and think in order to do this.

When the law was first passed, the standard had to be set quite low as the engineers were unprepared for it, and there had to be some exceptions made, such as special license, and the 5-year clause which allowed men who had run a plant requiring a certain grade license for 5 years previous to the law being put in force, to obtain that license without taking an examination. Had not such a provision been made it would have been an injustice to owners of steam plants, who wished to hire men to run them.

As the engineers acquired more knowledge of their work the standard has been raised and no special license is now granted for more than 150 hp. The 5-year men are dropping off, and no more of that class of licenses are issued; they are also required to hold a fireman's license before they can hold an engineer's license.

There are many men in the state of Massachusetts who have studied to perfect themselves and acquire one license after another, until they are able and licensed to take a position requiring a higher grade license than does the position which they now fill require. They are continually studying and looking for advancement. There are many hundreds such in the state and it would manifestly be an injustice to them were men allowed to come from nobody-knows-where, fill out an application at their pleasure and receive a license. The inspector cannot go to the trouble and expense of sending all over the world to find if their statements be correct.

If our friend had the knowledge and experience which he claims he could hardly fail of securing employment. If he wished to stay in Massachusetts and found himself late for one job he could reasonably expect to secure some other if prepared for it.

I do not see as any one was inconvenienced but himself; he does not say it was necessary to shut down the plant because he could not get his license.

I can imagine our friend arriving at the railroad station too late for his train and feeling that an injustice has been done him because the train with its hundreds of people were not kept waiting for him—even though ignorant of his coming.

E. E. Russell.

FILTER PIPING

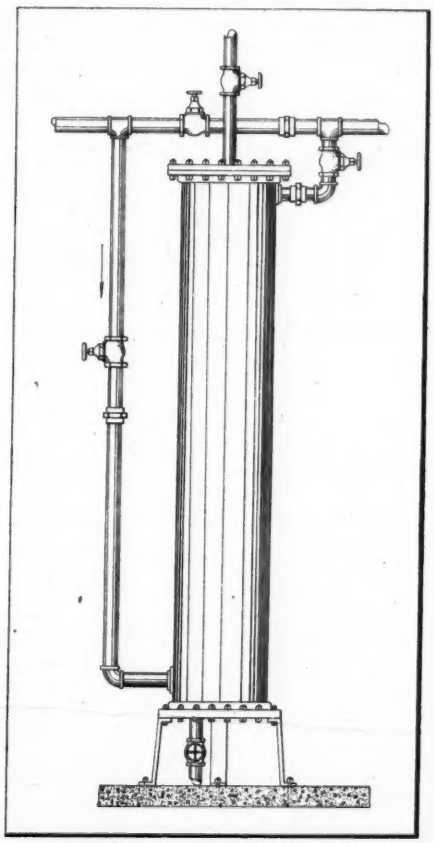
I WAS very much interested in the sketch and description of feed-water filter submitted by John Mitchell, in Practical Engineer for September, in which he asks for opinions as to the ruling of one of the insurance companies. It appears that virtually one-half of the filter is put entirely out of use.

Now there are 2 sides to this question, and each side is entitled to consideration. It is doubtless true that when the insurance company made this ruling, it had an eye to business, knowing the nature and disposition of oil when brought in contact with water.

Any oil carried along with the water, and entering the filter from the C connection, through the pipe, as shown by the dotted lines, will immediately, upon entering the filter (in effort to separate itself from the water), take an upward course and land at the top of the filter. Any oil (through the high velosity of the water) that by chance is carried to the bottom of the filter, is not going to remain there, but proceed on with the water. This prompts us to suggest that Mr. Mitchell is proposing to use this filter backwards, or passing the water through the filter the wrong way to be successful as an oil separator.

In a filter of this kind, the separation of foreign matter from the water, is best accomplished by filtering "up" instead of down. This is where gravity has its inning.

Now view the sketch in question, and suppose that we cut loose the 2 connections C and D, from the feed line, and turn the filter half around, and the present D pipe be connected into the feed line at C, for an intake to the filter, and the present C line connected at D, for a discharge from the filter. Now the water properly enters the filter at the bottom, and a good portion of the foreign matter, carried in suspension by the water, will find lodgment in the bottom chamber, which should have a hand-hole plate for access for cleaning. Any oil passing through the filtering material with the water, will find lodgment in the top chamber just as high as it can get; where it can be drawn off and passed through an oil filter and used again, if it is in sufficient amount to pay for the trouble. The occompanying sketch shows my idea.



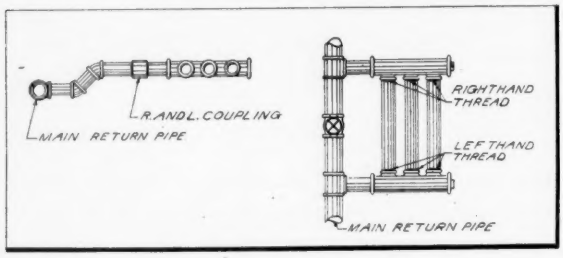
CONNECTIONS FOR FILTER

For flushing and washing the filtering material, there should be tapped into the filter (near the top) a pipe equal in size to the pipes operating the filter, and a flushing pipe of equal size, or larger in the bottom, both of which should be thrown wide open under pressure when desiring to wash the filtering material, and it is proper to do this for good results in the opposite direction to that in which the filter is used. The half-inch connection referred to by Mr. Mitchell is entirely too small for good results. S. A. Smith.

INCREASING EFFICIENCY OF HOT WATER HEATING SYSTEM

HOT water is especially adapted for warming dwellings and greenhouses, owing to the ease with which the temperature can be regulated. The circulation through the pipes is produced solely by the difference in weight of the water in the supply and return, due to the difference in temperature, the colder the water in the return pipes, as compared with the boiler, the more rapid will be the circulation.

Just before the return main reaches the boiler, an indirect radiator is connected to it so as to increase activity of circulation, by causing water to cool a greater number of degrees by transit through a greater



CONNECTIONS FOR CIRCULATING RADIATOR

length of pipe, and by exposing it to cold air from outer atmosphere, as in cases where indirect radiation is installed for warming the air for ventilation, and radiators for direct radiation in the rooms for heating purposes.

To install this indirect radiator to increase the circulation of hot water, place 2 tees in the main return pipe with gate or globe valve (gate valve having preference) placed between them so as to cause the water to flow through the radiator when the valve is closed. The connection to radiator should be the same size as in return pipe. It is necessary to have 2 45 deg. elbows for an expansion joint, and a right and left coupling with a nipple connected to branch tee; the coil is constructed with one of the branch tees threaded left hand, the other having right hand threads.

To make the right and left coupling and branch tees tight on both ends when screwed up, the threads on the pipes must be full and clean. L. A. Danner.

THE FIREMAN TO THE RESCUE

TO demonstrate the fact that in at least one instance the fireman was not a degraded simpleton, as he is frequently, sometimes, most always, hinted, I contribute the following tale:

The chief of the plant where Jim fired was one of those cranky, grouchy individuals who knows a whole engineering profession from a gas pipe to a turbo-generator and is not a bit averse about letting it be known either. Jim was a sensible young man and kept his steam and boiler right on the dot and was burning less coal than any of his predecessors, but Jim and the chief did not run in parallel worth a "red," in fact the chief "fired" him nearly every morning, but the super. whispered in Jim's ear to stick and Jim "stood pat."

One morning a vertical engine driving a d. c. generator was running along while the chief was sitting with his feet on the desk reading a copy of Young Wild West Weekly, while a "grease pipe" was busily engaged capturing and dissecting flies over by a window. Jim had occasion to come into the engine room for a wrench and while passing the d. c. machine, noticed it was running faster than usual and stopped to investigate.

Presently she gave a lurch and it seemed as if she would leave the foundation. Jim let out a "Hey-y-y" Apache war whoop to attract the chief's attention and started for the throttle. The chief looked up wondering whether Indians were really getting wild, and noticing the racing engine proceeded to make himself hard to find, which he did in short order.

Jim saw that it was useless to try to get to the throttle in time to save the flywheel, as he would have to run nearly around the unit to the steps and climb upon the platform. The valve stem had about a yard of threads on it, too, and at the rate the engine was accelerating she would not last long. He made a run to the switchboard still holding his wrench which he threw across the poles of the main generator knife switch, hoping the short circuit would hold the speed down until he could get to the throttle.

The scheme worked fine and he soon had the runaway under control. The generator stood it all right, but it was about as hot as they ever get when it stopped. Upon examination it was found that a derangement of the shaft governor mechanism caused the engine to take steam full stroke regardless of the load.

After it was all over and the chief had returned, seeing what Jim had done, he was naturally sore and when he espied the wrench lying across the switch poles pretty well melted up, he gave Jim blazes for spoiling the wrench. Le Roy Scott.

PITCH OF BOILER

I WOULD like to call your attention to the article under the heading Blowoff Peculiarities, on page 748 of the November, 1911, issue of Practical Engineer, by Chas. H. Taylor, as I think there has been a mistake in regard to the pitch of the boiler illustrated. If the boiler really had a pitch of 1 in. to the foot, where would the water in the gage glass be when the top row of tubes at the back end was covered?

Suppose, for instance, that the boiler was 16 ft. long with a pitch of 1 in. to the foot; with the bottom connection of the water gage 4 in. above the top row of tubes and the top connection 14 in. higher, allowing for a water glass of say 12 in., the gage glass would be full of water with the tubes at the back end just covered.

If the boiler was worked, as a majority of boilers are, with half a glass of water, the tubes at the back end would be uncovered. It is a well-known fact that 90 per cent of the boilers in this country have their blowoff valves at the back end of the boilers, although I have seen a few connected to the front but with the pitch of the boiler to the back end. In England it used to be the reverse; 90 per cent being

at the front with a pitch of 1 to 1½ in. for the entire length of the boiler towards the blowoff valve.

John Mitchell.

Allow me to thank you for calling my attention to the error in my article in the November issue. I wish to compliment the reader for his criticism, as it plainly shows that the readers of Practical Engineer are certainly on the job when looking over the contributions to its columns.

The article should have read that the boiler had a pitch of 1 in. in the length of the boiler. I referred to a boiler that I ran across which had the blowoff pipe in the front end and was pitched toward the front end instead of to the rear as is the usual custom. The water gage was set 2½ in. above the tubes, thus leaving the tubes covered 1½ in. when water was showing at the bottom of the gage glass.

Chas. H. Taylor.

PUMPING ENGINE CARDS

ANSWERING F. C. Holly's comments on cards from pumping engine, in the November number of Practical Engineer, will say that I supposed that all the necessary data was given when I sent the cards, if not, it was an oversight on my part. I can, however, supply the data at this time.

The cylinder sizes are 14 and 24 by 22 in. stroke, 26 r.p.m., steam pressure 110, vacuum 26½ in., spring 60 for the high-pressure cylinder and 20 spring for the low-pressure cylinder, and works against a head of 184 ft.

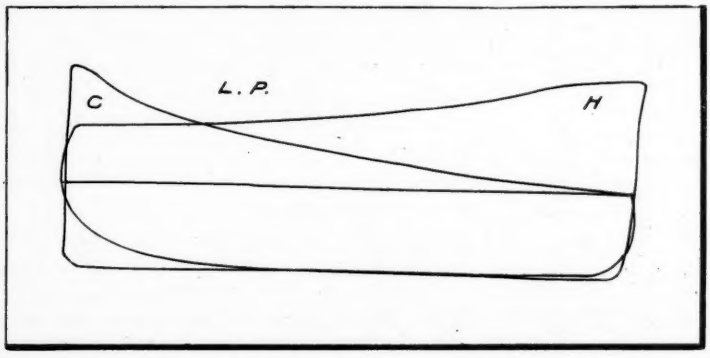
There is a governor on the engine which normally is operated by the water pressure through suitable mechanism to the cutoff gear, which is also adjustable by hand while the engine is in motion. The governor has never been used, and has become so badly rusted in its bearings that it is impossible to move it, and, as the pump is in constant use, day and night, I have had no chance to get it in working condition, but hope to this winter.

This condition of affairs compels us to regulate the engine by the throttle, which accounts for the late cutoff, and the low pressure in the high-pressure cylinder.

The valves are of the Corliss type. The wrist-plate takes its motion from the eccentric, while the cutoff is worked from the rocker arm.

I am sending a card taken from the low-pressure cylinder of the left-hand engine, and I would like to have Mr. Holly, or any of the readers of Practical Engineer, tell me what, in their opinion, is the matter with the card compared with the one from the same cylinder, as shown in the October number of Practical Engineer.

W. P. F.



CARD FROM LOW-PRESSURE LEFT HAND CYLINDER OF PUMPING ENGINE

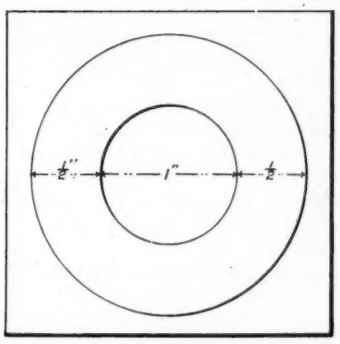
FIGURING STRENGTH OF BOILERS BY SIMPLE METHODS

RULES upon rules for determining the strength of boilers with their many exceptions and variations bewilder and confuse some of our best operating engineers, and in order to get straightened out I went back to first principles and thought out a method of my own, simple and not easily forgotten, so I present it herewith.

Considering a boiler 1 in. in diameter and a section 1 in. long with ½-in. plate the section area would be 1 sq. in. and hence if the strength of the iron or steel is 50,000 lb. per sq. in., 50,000 lb. would be required to burst it. If the boiler is 50 in. in diameter the bursting strength would be 1/50th of 50,000 or 1000 lb. and the safe working pressure would be 1/6 of that or 160 lb. provided there were no seams. A single riveted seam has only 50 per cent of the strength of the plate and a double riveted seam 70 per cent, consequently 83 lb. would be the working pressure for a single riveted boiler and 116 lb. for a double riveted boiler of the above dimensions.

Boilers of the same thickness and same number of rows of rivets, all made out of the same material, will vary in strength in proportion to their diameters, thus the bursting strength of a boiler 1 in. in diameter with ½-in. plate would be 50,000 lb.; a 2-in. boiler, 25,000; 10-in boiler, 5,000; 25-in. boiler, 2,000; 50-in. boiler, 1000. If the above plate was only ¼ in. thick then the bursting pressures given above would be divided by 2. If the boilers were made of 1-in. plate the bursting pressures would be double that given above. In other words the strength of a boiler increases directly as the thickness of the plate.

George Gilford.



SECTION OF 1-IN. BOILER OF ½-IN. STEEL

STACK RAISING

RAISING a stack is purely practical work, and a piece of work that many think to be much more difficult than it really is. The whole secret in raising a large or small stack is in the preparation, or as commonly called, getting the rigging ready. The present example will serve as a rule to be followed and illustrate the method I use.

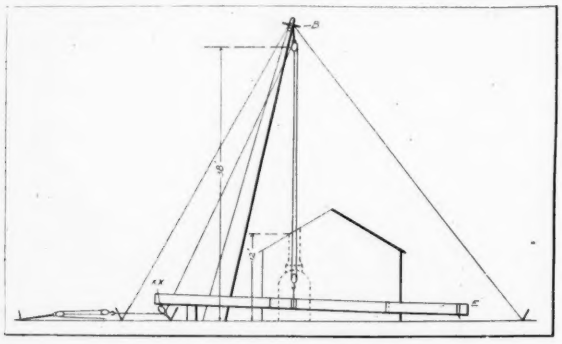
First, we must take into consideration the length of stack which we have to raise and, of course, its weight which we must raise entire, and with some factor of safety as well. We must also know how high we are going to place the base of this stack

above the ground as this, with the length of stack, will determine the length of our gin pole to which we are to fasten our hoisting ropes.

For an example, if we were going to raise a stack 50 ft. long and place the base on a level with the ground, then we should want our gin pole about 30 ft. long so as to allow us to fix our sling for raising about the middle of the stack; and this would also allow some leeway for the stretch in our ropes, which is sure to come in the lifting.

In the example which we have before us, we are preparing to raise a 50-ft. stack and as we have to lower this stack through the roof we are compelled to raise the entire stack so that the bottom end will clear the roof. As this roof height is 12 ft., we are adding this on to our gin pole and get a gin pole 38 ft. long; by making our slings heavy and short so that they will not give much we can raise the stack and set in place with this height of pole.

We should set the pole as close to the stack opening as possible; while the one shown in the example is some distance from the opening, we can set the



METHOD OF RAISING STACK

stack in place by this pole. The first thing is to raise the pole. For small or short poles they are usually raised by the aid of pike poles such as used by electric linemen for setting poles; but in many cases we would set up a small gin pole and with this raise the larger one with which we were going to raise the stack.

It is a good idea to bore a hole right through the top of the pole and put in a piece of iron rod to keep the rope slings from slipping down. This pin is shown at B. The rope sling can be fastened around the pole above this rod and the guy ropes can also be fastened securely about the top. Being fastened, these ropes can be used in the raising of the gin pole and for steadying it while the guys are being fastened. These can be secured to trees, buildings, bars driven into the ground, or anything that is handy for an anchor.

We now place a good rope sling about the middle of the stack, and this sling must be made with a noose, bowline or timber hitch, so that it will tighten when the strain comes on and not slip. It is usual practice to let the end of the stack E be the heavier end, yet in many cases where we had a short gin pole we have tied a rope to the end E, put several men on this and raised the stack. It is well to fasten a rope to this end for the purpose of guiding the stack and to prevent swinging when lifting, and when we are to raise a stack and set it in a hole as shown by the drawing, it is best to have several ropes fastened about the top of the stack so that we can pull the stack into a vertical position.

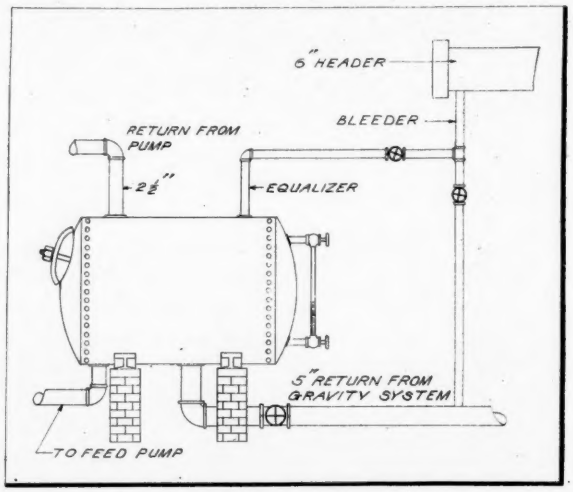
We can arrange a snatch block at the ground as shown at XX and letting the pole rope come through this we can fasten to this a smaller set of rope blocks and do our lifting. Or should we have a windlass or crab winch we can possibly raise without the second set of blocks; either way will be all right. Fix everything strong and secure before attempting to start and you will be surprised how simple and easy it is to raise a stack. C. R. McGahey.

RETURN TANK CONNECTIONS

FOR some time after taking charge of the plant I am now in, I had considerable trouble with my indirect room heating coils filling with water and flowing out at the air vents.

There are 2 systems with only one return tank, the returns from one system being pumped to the tank, while the other returns by gravity.

I concluded that the pump was the cause of the trouble, by raising a back pressure on the tank, thereby causing the returns from the gravity system to back



PIPE CONNECTIONS TO RETURN TANK

up and flood the coils. So I put an equalizer between the tank and the gravity system header of ¾-in. pipe with a valve between the 2, which I keep open about one turn while the systems are in service, and this did away with the flooding. Fred Wagner.

WHAT TO DO IN EMERGENCY

IN answer to A. H. Strong, page 754, Practical Engineer, November, I would say that if the high-pressure engine is on center, the exhaust valve is open on opposite end. Raise dashpot rod and open steam valve on end where exhaust valve is open and let steam through to low-pressure engine to start.

2. In the emergency stated, place the piston at one end of the cylinder; disconnect connecting rod from crank pin; disconnect valve gear from eccentric; open exhaust valve and open steam valve on the same end as the exhaust is; open so steam can blow through and run the low-pressure engine to do the work.

As the low-pressure engine is much larger than the high-pressure—usually 2 times the diameter and 4 times the area—you would need but about one-fourth the pressure. As the low-pressure engine is not built to stand the strain of the high-pressure, care should be taken not to let the pressure get too high.

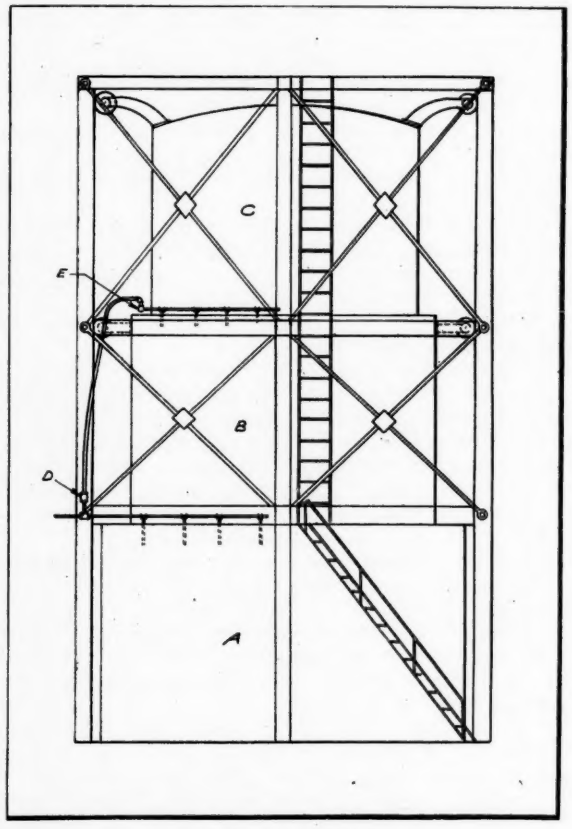
E. E. Russell.

WARMING SEALS OF A GAS HOLDER

AT our plant we have a 2-lift gas holder and as there may be some who do not understand the operation of one, I will explain it briefly.

The bottom tank A is the largest and is filled with water; if the holder is entirely empty, both lifts B and C are telescoped in the bottom, and as the gas enters the holder and commences to raise C, it engages B and draws it up. The cup between B and C is sealed with water, having been filled when it was down in tank A, and as the 2 lifts lock together the water is held there.

The second lift B is sealed with the water in A. In the winter these water-seals have to be kept warm, for if they freeze, they would hold the lifts up and the crown-sheet would collapse. A steam pipe is run and enters the large tank by a piece of 1¼-in. pipe with branches of ½-in. at intervals of about 4 ft. A tee is placed at E and steam is carried to the seal between



TWO-LIFT GAS HOLDER

the 2 lifts by a steam hose entering the cup by the same method as in the lower tank.

One morning last winter I went up to this cup and found about 8 in. or more of water gone (it should contain about 14 in. of water). Now the question was, where had the water gone.

Upon investigation I found that steam had dropped during the night, it being a fairly warm night, and so I concluded that there not having been enough pressure to force the steam up through the 25 ft. of hose to the cup, the steam running by into the lower tank had formed a syphon and drawn the water from above down through the hose to the tank below. I placed a check valve above the tee at D and now the water cannot get out of the upper cup. H.

READERS SERVICE DEPARTMENT

ITS AIM AND WHY STARTED

"EVERY man for himself alone"—may have been good policy in years gone by, but now the greatest successes are the result of combined effort. So this department invites you to send your engine room troubles that seem hard to solve and receive in return, suggestions from the other readers of Practical Engineer.

The kind of help this department gives is illustrated in the following letter:

Dear Sirs:

We have a 3-phase revolving field type alternator direct connected. The machine is labeled thus:

K.V.A. 50, Rev. per min, 300, Volts 120, Amperes per term. 240, Cycles 60. There are 50 amperes on one phase, 25 on another. The exciter is belted from the large generator.

The exciter runs all right and does not spark until it has made 5 or 6 night runs on a half night circuit; then it sparks badly and a burnt spot appears on one side of the commutator, as long as the commutator, and taking in about 4 segments or commutator bars.

After sandpapering it down smooth it runs about the same length of time and the same thing appears. What can I do to remedy this burnt spot that appears on the commutator of the exciter?

This is the answer from the Readers Service Department:

Dear Sir:

In regard to the action of your exciter, from what you say we should suspect that you have a hard mica division in the commutator at the point where the burning occurs, that after the copper has worn a little this high mica sticks up and causes the brushes to jump, this making a spark which will burn the commutator.

You can tell about this by running the point of a pencil or your finger nail around the commutator at the point where the sparking takes place, and you will probably find there one or 2 mica partitions that are a little high.

This would seem to be the only thing likely to cause just the conditions you describe. The remedy is to cut this mica division out a little below the surface of the copper after sandpapering.

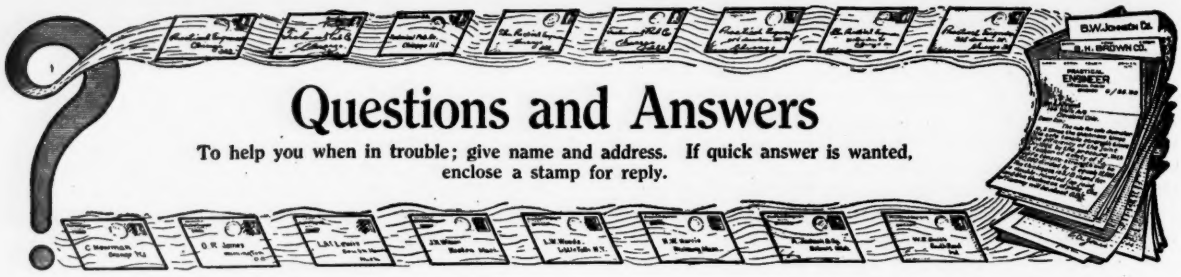
The reader's answer:

Dear Sirs:

In regard to your advise on the burned spots on the commutator of the exciter to our alternating unit will say after a close examination the case was as you stated. The trouble was due to 2 mica strips between the bars that were higher than the surface of the commutator. After dressing down the commutator with a fine file, the trouble disappeared.

This illustrates the service the department performs in the "trouble" end of your power plant work.

This department is ready at all times to give you opinions from the editorial staff, and if necessary, get expert advice from a specialist in any line and give you the information he furnishes free of charge. A letter addressed to the Readers Service Department will be answered promptly.



Questions and Answers

To help you when in trouble; give name and address. If quick answer is wanted, enclose a stamp for reply.

ANSWERS TO THE CHIEF ENGINEER'S CATECHISM VII

By Wilmer R. Hersey

PRIMING may be the result of several causes, the chief of which are poor circulation, steam space too small and forcing the boiler beyond its capacity. Poor circulation will cause the water to be thrown into the steam space by the bubbles of steam rising too rapidly at some point. In return tubular boilers this may be remedied by removing the 2 center rows of tubes; this will improve the circulation and stop the priming. When the steam space is too small about the best one can do is to carry the water as low as safety will permit and have a dry pipe put inside the boiler.

2. The maximum temperature of feed water obtainable is about 212 deg. F. with the open type of heater and 200 deg. is considered very good. The closed heater should raise the temperature of the water to very nearly the temperature of the exhaust steam. This will depend on the back pressure carried.

3. A live-steam purifier should raise the temperature of the water to the temperature of the steam and water in the boiler.

4. The choice of a pump depends on so many conditions that no one type of pump is best for all plants.

In small and medium size plants where the exhaust from the main engine is available for heating the feed water, I would install a triplex power driven pump, because the main engine will develop the power to run the pump much more economically than a steam pump could, and as we do not need any more steam for heating the feed the heat in the exhaust of a steam pump would be lost.

Where the engine is condensing I would use a duplex steam pump and use the exhaust to help heat the feed.

In a large central station I should install a turbine driven centrifugal pump, because the exhaust will help heat the feed, the flow of water is steady in the pipes, the simplicity and small number of moving parts and the absence of much friction help to keep the repair bills down.

5. A 500-hp. boiler will evaporate approximately 17,200 lb. or 2330 gal. of water from and at 212 deg. F.

Now, as the boiler under pressure will not evaporate this amount of water to find the actual amount of water we must furnish, divide the equivalent evaporation by the factor of evaporation.

The factor of evaporation is the total heat of 1 lb. of steam at the pressure carried minus the heat of the feed water plus 32 deg. and this divided by 966.1.

We do not want to have to run our pump at full speed all the time so we will select a pump capable of handling 1.5 times the amount of water needed.

6. I would allow a velocity of from 8 to 10 ft. per second. This is enough to keep the pipes comparatively free from sediment and scale and not enough to increase materially the working head on the pump.

7. A pump is said to be steam bound when the water in the suction side is so hot that it vaporizes as fast as the plunger creates a vacuum, therefore the pressure of the atmosphere cannot force the water up to the pump.

When a head of water is on the delivery valves, and air gets in the water cylinders, the pump cannot get rid of the air because as the plunger advances the air is compressed and on the return stroke it expands so that the plunger cannot create a vacuum in the suction pipe. When this condition exists a pump is said to be air bound.

8. I would use screwed fittings on all pipes to 3½ in. in diameter, screwed fittings in making up sections in pipes from 3½ to 5 in. with flange section joints, all fittings over 5 in. to have flange joints.

9. No one type of valve should be used for all purposes on a steam line.

For the stop valves on boilers I prefer a globe valve, one that will seat over the packing box when open, so that the box can be packed. It should be placed in the line so that the disk screws in against the pressure of the boiler it protects, because when so fitted with no pressure on the boiler the pressure from the line will hold the valve seated and working inside the boiler will be comparatively safe.

For stop valves in the piping system I like gate valves of the outside screw and yoke type, and if of large size fitted with a bypass.

These valves do not offer any obstruction to the current of steam and will remain tight in this position as long or longer than a globe valve, and they are not so liable to break.

10. I would provide for expansion by the use of long bends in the pipe if possible, if not I would use an expansion joint. Short pipe lines need not be anchored, but the longer lines should be securely anchored half way between the expansion bends or joints.

The formula I use to find the allowance for expansion is as follows E=C L F.

Where E=the expansion of pipe in inches L=length of pipe in feet, F=rise of temperature in degrees Fahrenheit, C=the expansion in inches per 1 ft. of length per degree rise in temperature. For cast iron pipe it is 0.00007404, for wrought iron pipe 0.00008232.

By Fred A. Kendall

There are several causes of priming, of which the most common are the following:

1. Water line carried too high.
2. Irregular firing.
3. Sudden opening of stop valve.
4. Defective design of boiler.
5. Insufficient boiler power.

The remedy for a priming boiler depends upon the local conditions that cause the boiler to prime. When priming takes place it can be checked temporarily as follows: Close the damper and thereby check the fire until the water is quiet; the engine stop valve should also be partially closed to check the rush of water.

2. The maximum temperature of feed water obtainable in a heater using steam from a noncondensing engine depends upon whether you use an open or closed heater. For instance in a closed heater if the quantity of exhaust is sufficient, and the heater is ample in size, it is possible to raise the temperature of the feed water to 212 deg. F. exhausting at atmospheric pressure; while on the other hand if we put a back pressure valve on the outlet, the degree of heat in the feed water will depend upon the amount of back pressure.

3. The temperature to which a live-steam purifier will raise the feed water depends upon the pressure in the heater. All conditions being right, the temperature of the feed water will be within 5 or 6 degrees of the temperature of the steam in the shell.

4. In regard to style of pump for boiler feeding, I prefer the centrifugal pump, turbine driven. Of course, local conditions will have some influence in regard to the style of pump used. The centrifugal pump has many advantages over other types of pumps, delivers larger volume of water, takes up very small floor space, gives very little trouble, is always ready to do its work, you can close the feed valve on your feed line while your pump is running without doing any harm, also you can use the exhaust steam for heating purposes and return the drips into your boiler without any danger of getting oil in your boiler.

5. What size pump is required to furnish water for a 500-hp. boiler, we will consider a duplex pump. One horsepower being defined as the evaporation of 30 lb. of water per hour from 100 deg. F. into steam at 70 lb. pressure or 34½ lb. per hour from and at 212 deg. F. $500 \times 34\frac{1}{2} = 17{,}250$ lb. of water will be required per hour; reduced to pounds per minute $17{,}250 \div 60 = 287$ lb. Reducing the pounds to cubic feet, we have $287 \div 62.35 = 4.6$ cubic feet per minute. To find the the diameter of a plunger or piston in inches, multiply the discharge in cubic feet per minute by 183.34 and divide the product by the piston speed in feet per minute. Extract the square root of the quotient.

Applying the rule we get

$$D = \sqrt{\frac{183.34 \times 4.6}{100}} = 2.91 \text{ in.}$$

A duplex pump $4\frac{1}{2} \times 2.91 \times 8$, making 150 strokes per minute, will supply a 500-hp. boiler theoretically. Since there is always more or less slip of the water, it is usual to design the pump on the assumption that it must pump 1.25 times the actual amount of water. Considering all local conditions, slip overloads, etc., I would recommend a pump $5\frac{1}{4} \times 3\frac{1}{4} \times 10$ for a 500-hp. boiler.

6. The velocity of flow in the discharge pipe should not exceed 500 ft. per minute. The volume of discharge and the length of pipe vary so greatly in different installations that the size of the discharge pipe should be calculated for the particular conditions, allowing no greater velocity than 500 ft. per minute.

I would recommend a velocity 250 to 400 ft. per min. if excessive wear and tear is to be avoided.

7. The term steam bound is usually applied to pumps which are used for pumping hot water from open heaters or receiving tanks; when they fail to operate because the height of water above the suction valves is not sufficient to open them and the vacuum formed by the pump causes the water to vaporize and the pump runs away, clattering or pounding according to the amount the throttle valve is open.

A pump is said to be air bound when the air pressure in the cylinder in front of the advancing piston is not sufficient to open the discharge valves and too great behind the piston to permit the water to follow to the pump.

It is caused by large clearance space in the water cylinder, by leaking piston and valves and by a high suction lift or by a combination of all 3 conditions; an air-bound pump will run at a high rate of speed and knock at the ends.

8. On steam piping I would recommend screw fittings up to 2 in. in diameter; above 2 in. I prefer flange fittings, because they are more convenient to install, also if the job is properly done you will not be troubled with leaks.

9. I would recommend globe valves up to 6 in. in diameter in preference to gate valves, because it is more convenient to keep them tight; you can renew the disk and regrind the seat if necessary; other conditions being good, your valve is practically as good as new.

My reason for limiting the size of the globe valve is because anything larger than 6 in. would be very awkward, also very expensive. Once a gate valve gets to leaking, it is almost impossible to stop it without refacing the disk and seat or putting in new seat rings, which ever the case may be. In this case a great many times it would be necessary to send the valve to the factory to have this work done. While with a globe valve any intelligent engineer can put a new disk in and regrind the seat.

10. The expansion of a steam pipe is taken care of in a number of different ways. There are a number of different makes of expansion joints on the market for this purpose, where the pipes are very long; but for the ordinary piping the expansion can be taken care of through the fittings and long bends if properly constructed.

The maximum expansions of a steam pipe will be approximately 1 in. to every 100 ft. of pipe.

Grinding of Gears

IN a 1910 Buick automobile, model 17, rated at 40 hp. there is a 4-cylinder gasoline engine, and when we change the speed from slow to intermediate, there appears a hard grinding in the gear case as if the cogs were not in mesh. On examination the cogs show no signs of trouble.

Can anyone tell me how to remedy the difficulty and what causes it? V. K. S.

Strength of Water Tank

IT is desired to construct a water tank 16 ft. diameter, and 10 ft. high; materials are wood staves and iron hoops.

We find that the pressure at bottom is 4.34 lb. per sq. in. What would be the strain on hoops spaced 1 ft. apart, and what is the formula for finding it? Using a factor of safety of 6, what size hoops would I need? C. A. E.

A. The pressure in your tank would be, as you say, 4.34 lb. per sq. in. at the bottom. Assuming, as

we would have it, that the staves have no holding power, the pressure to be taken care of in the hoop would be that exerted on the area 1 ft. high and 16 ft. long, or reducing this to sq. in. would be 12×16×12 to give the area, and this multiplied by 4.34 to give the total pressure. This gives approximately 10,000 lb. as the total pressure.

This is resisted by the hoop at 2 points, so that 5000 lb. would be the load carried at each point on the hoop; with the factor of safety of 6, the bursting

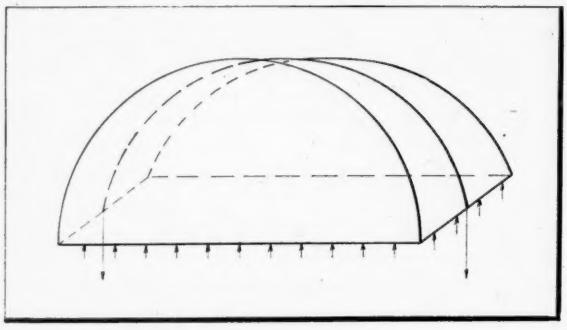


DIAGRAM OF STRESSES ON TANK

strength would have to be 30,000 lb. For mild steel or wrought iron this would require an area 30,000÷55,000 or 0.545 sq. in. If you are using round hoops this would call for ⅞-in. rod to be on the safe side.

The sketch herewith shows the arrangement of the forces.

Gas Engine Rod Packing

KINDLY inform me as to the best packing and way of using it in a piston rod between the 2 cylinders of tandem gas engine. We have trouble with packing drying or burning hard and blowing badly after very few hours' use. It appears all right when engine is started, but as soon as it gets warmed up it leaks and no amount of adjusting or tightning or loosening seems to affect it. W. R.

A. Replying to your letter, as a general proposition the best packing to use is a metallic packing, with the understanding that the "firing ring," i. e., the ring next to the cylinder, will in time burn out and must be replaced. In packing such a ring, it is necessary to avoid babbitt metal or brass, since the softer metals will not stand the high temperature of the burning gases without melting. The dimensions of the particular stuffing box in question are 1 in. depth, 1¾ in. diameter, 1⅛ in. diameter of rod, which means that 5/16-in. packing may be used. In addition to this the box and gland are beveled.

These dimensions are evidently too small for the use of metallic packing, and that is out of the question.

Our first suggestion would be the turning up of 2 beveled metallic rings, probably of cast iron to fit exactly the bottom of the box and the gland, so as to square the bottom of the box and the gland. These rings should be split so they can be inserted, but made so that they will fit fairly tight around the rod. If made to a machine fit, the expansion due to heat would cause them to bind and give difficulty.

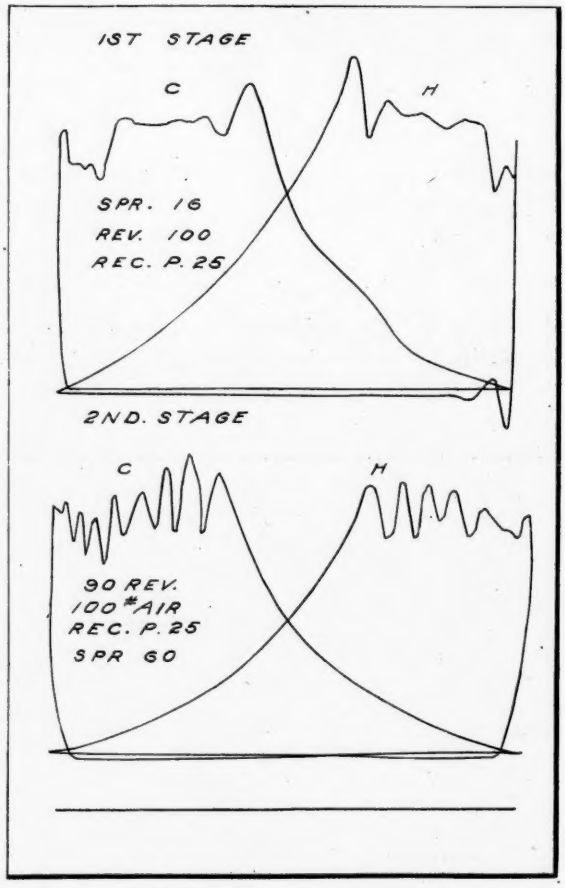
For the packing proper between the top and bottom of the box, use asbestos. This asbestos may be made up in 2 sizes. It can be made by wrapping asbestos cloth around a mandrel to make the required size and cutting it into rings so that it can be inserted or it can be made from rings cut from a tightly woven asbestos spiral packing. A loose asbestos would not be satisfactory.

When first using these rings, they should, for some time, be continually lubricated with graphite and only enough oil to carry the graphite. If too much oil is used, the intense heat will break the oil down, leaving a gummy substance which will be unsatisfactory. On the other hand, the graphite will fill in the pores of the asbestos and tend to make a smooth surface on the asbestos, as well as on the rod, a surface that will not be affected by the heat and at the same time will give the best conditions, i. e., making the rod and the packing 2 almost perfectly smooth surfaces, with as little friction as possible, which is the ideal condition.

I believe if these directions are followed out and the asbestos chosen with care so that the box will be completely and snugly filled, and if this is started well so that it is thoroughly lubricated with graphite, that the packing will work to entire satisfaction for an indefinite length of time. W. E. Sanders.

Air Compressor Cards

INCLOSED cards are from an Ingersoll Sergeant air compressor with speed ranges from 7 to 120 r.p.m., and the cylinders are 16½ by 25 by 24 in. The piston inlet is used with the common style of discharge valve.



CARDS FROM AIR COMPRESSOR

Would some of the readers offer any suggestions in regard to the working of the cylinders? F. B.

Cooling Pond

PLEASE give me description and sketches showing dimensions, etc., of cooling pond for condensing engines for 100-hp., also giving additional area necessary for each 100 hp. up to 1000 hp. C. D.

A. Tests on cooling ponds have given such varied results that an absolute rule or formula is impossible. Winds, temperature, humidity, location and other factors all tend to produce very divergent results. The following data will be found ample and safe for your case. Let the cooling surface have an area of 85 sq. ft. per hp. hr., supposing the engine to run 24 hr. per day, using 25 lb. of steam per hp. hr. Depth of pond 3 ft.; temperature atmosphere, 52 deg. F. This data is based on a reduction in temperature of 122 to 82 deg. F.

A 100-hp. engine would then require 8500 sq. ft. of pond surface and 8500 sq. ft. for each additional 100-hp. For temperatures above 52 deg. F., the area should be somewhat increased.

A sketch, Fig. 1, gives an idea of a cooling pond for a 100-hp. engine. The position of a dyke brings the coolest water to the suction pipe.

With a view towards facilitating evaporation and reducing the size of the pond, the water is often distributed through pipes and discharged upwards through nozzles. Sketch 2 shows such an arrangement.

Deducing from the data on a pond of this type,

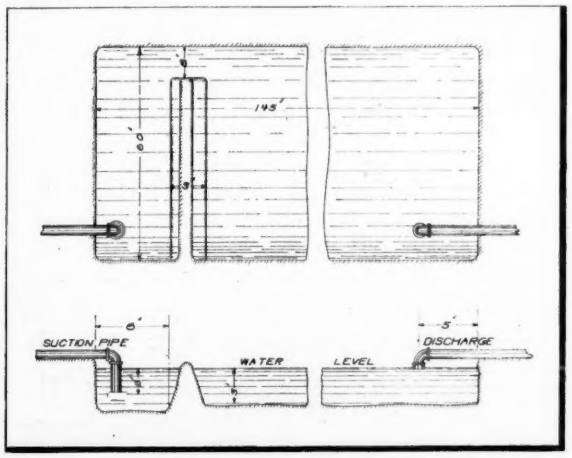


FIG. 1. COOLING POND FOR 100-HP. ENGINE

supplementary to the 3000-hp. plant now in successful operation, the following should be a safe calculation for the plant of 100-hp. capacity: Area 3000 sq. ft. or 30 sq. ft. per hp.. depth, 3½ ft.; discharge nozzles, ¾ in. in diameter, the nozzle having a spiral core giving the water a whirling motion which greatly aids in its spraying effect. A nozzle of this size, supplied with water at about 8-lb. pressure, will discharge about 270 lb. of water per minute to a height of approximately 15 ft.

$$\frac{100 \times 25 \times 30}{60 \times 270} = 5 \text{ (Approx.)}$$

or the required number of nozzles. Nozzles are inclined at an angle of 30 deg.

Arrangement of Heating Surface

WE have a dry room 60 by 20 ft. in which I wish to put 3 heaters 20 ft. long by 14 ft. wide, each containing 180 ft. of 2-in. pipe with a 6-in. header on each end, one for the steam supply and one to carry away condensation. The steam header will be connected to a 6-in. supply line by a 2-in. pipe, exhaust steam being used. The drip pipes are 1¼-in.

Another arrangement suggested is to use 2 heaters, one 36 by 14 ft., the other 24 by 14 ft. I think we would get better result from the 3 heaters for the following reasons: In the short heater we have 180 ft. of 2-in. pipe or 1363 ft. of heating surface connected with a 2-in. line to a 6-in. supply line. The 36-ft. heater would have 2417 ft. of heating surface which would be fed in the same way as the shorter heater, by 2-in. connection to a 6-in feed line. This is an addition of nearly 1000 ft.

The suggestion is to overcome this extra surface by putting in a larger connection from the 6-in. header to the 6-in. feed line, or to put in 2 2-in. connections,

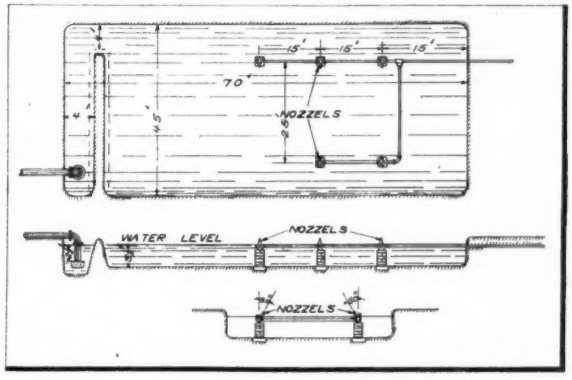


FIG. 2. COOLING POND EMPLOYING SPRAYS

one at each end of the 6-in. header. I think this would do no better because we could get no more steam into the 2-in. pipe than into the 3-in., regardless of the size of connection so long as we have only 1¼-in. drip. I believe we can keep a higher temperature in the dry room 60 by 20 ft. with 3 heaters 20 by 14 ft. than with the 2-heater arrangement. C. P.

A. In regard to your heating problem, where you get the feet of heating surface that you mention; 180 ft. of 2-in. pipe would be 111.78 sq. ft. of heating surface or 3 such radiators would give 335.34 sq. ft. In the other arrangement a 36-ft. by 14-ft. radiator would give 201.2 sq. ft., while the 24-ft. radiator would give 134.12 sq. ft. or a total of 335.32, so that the total heating surface is the same by the 2 arrangements.

According to the best practice, to supply 111 sq. ft. of heating surface would require 1½-in. pipe or to supply 201 sq. ft. would require 2-in. pipe. It would seem, therefore, that the 2-in. connection should be ample for either radiator. For the return pipe or drip the 1¼-in. is ample for 111 sq. ft., but is small for the 200 sq. ft. radiator.

We do not know, of course, the reason for desiring the 2-radiator arrangement instead of the 3 unless it be cheaper cost of installation. It would seem desirable that the return pipe should be made 1½-in. if the larger radiators are to be used.

WALTER B. SNOW announces the recent addition to his staff of Sidney G. Koon, for 4 yr. editor of International Marine Engineering, and later metallurgist, Jones & Laughlin Steel Co.; and also the addition some time since of John S. Nicholl, lately with the New York Edison Company, and formerly acting manager for F. W. Horne, importer American machinery, Yokohama, Japan.

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1911 INDEX

The index for Volume XV of Practical Engineer is now ready and will be mailed to anyone desiring it on receipt of postal card request.

USING CHEAPER FUELS

With the increase in use of anthracite as a domestic fuel, and particularly with the adaptation of house-heating boilers to the use of smaller sizes which have heretofore been available for power purposes only, the hard coal supply passes more and more out of the province of the power plant engineer. We have heard much of the extortion of the "coal barons" and of the arbitrary prices fixed by them, but the investigation of conditions made by the U. S. Geological Survey holds out no hope of lower prices in the future.

The only reason that the smaller sizes of anthracite coal have held at the low prices which have prevailed in the past and which were really less than the cost of production, was because they were not available for domestic use and, therefore, were sold for what they would bring in competition with the bituminous coals. Higher prices on the larger sizes which have heretofore been known as domestic coals have forced domestic consumption to take on the smaller sizes and this has in turn increased the price of these sizes. Increase in cost of labor and of transportation are working to increase the price of the larger domestic sizes as well as to raise the price of the smaller sizes which are now being classed as domestic, all this resulting in the taking of anthracite coal out of the power field.

Not only this, but better understanding of the proper conditions for burning the higher grades of bituminous coal in house heating apparatus is resulting in a large increase of the use of such coals for domestic purposes so that, in the comparatively near future, the relation of price to heating value in the high grade bituminous coals will have the same trend as has been the case in the anthracite, and for large power users the cost per heat unit for the cheaper coals will be less than with the high grade bituminous. Under these conditions it will become necessary to adapt power boilers to the use of the cheaper fuels.

Looking toward the time of this development, the work of the Fuel Testing Plant of the Geological Survey will be found of the greatest value. Experiments as to availability of different low grade coals and lignites, both for boiler use and for use in gas producers has brought out many facts which will help in solving the problem. For one thing, the possibility of using low grade fuels for the making of illuminating gas has been proved and a recent bulletin of the Bureau of Mines deals with the coals available for the manufacture of illuminating gas. Heretofore the bituminous coals of Western Pennsylvania have largely been used for this purpose, but they will be among the high priced coals of the near future and the delay of the

rise in price will be assisted by turning the gas companies to the lower grade coals for their supplies.

Investigations of the Testing Plant shows that some coals from which good yields of gas had been expected cannot be used for illuminating gas, while others in comparatively undeveloped fields have been found promising and will probably be available at less cost than the former supply. On the other hand, some of the coals which will not give good results for illuminating gas manufacture are found available for power boilers.

Along this line of investigation lies a great possibility for saving in the matter of purchasing coal, and the engineer who is looking to reduce plant expenses will do well to keep himself thoroughly posted as to the new fields which are being investigated, the properties of coals as shown by the tests, and the prices at which such coal can be bought for his use. This information is, of course, available without cost to those who keep in touch with the Director of the Bureau of Mines, Washington, D. C., and ask for the bulletins on coal testing.

For those who are contemplating new installations or alterations of plants it will be well worth considering whether the new furnaces should not be so arranged as to handle the cheaper grades of coal either at the present time or by comparatively inexpensive alteration when, with the rise of coal prices, the need for burning low grade coals becomes imperative.

LEARNING THE ROPES

REPORT OF PROGRESS FROM THE CUB FIREMAN

DEAR FATHER:

I received your recent communication in due time and carefully read its contents, not only once but several times, and now have it nearly memorized. It is now about six weeks since I began that journey up the 1000-mile ladder, and I am confident that I have started at the right place, thanks to your advice.

Truly, I am getting to be quite a power plant man, for the fellows no longer look sidewise at me as they did at first. I heard one big chap say, the fourth or fifth day, "There's another of those mama's little boys 'round here spotting on us fellows just because his dad's got stock in the concern." I believe that I could have made him take that back but I thought of your advice and concluded that time would make him see the error of his ways, so I swallowed my wrath and said nothing.

The other day I asked the chief engineer how much coal they burned in a day and he said he didn't know because he didn't have time to find out; they got it in carload lots and took the shipper's weight. I asked him if he could get me a pair of scales, and, of course, he wanted to know all about it, and I told him.

He looked at me a minute and then walked away, evidently so busy thinking that he didn't have time to reply. In a couple of hours along came some laborers with a pair of scales which I located handy to the coal bin and firing floor, and proceeded to weigh the wheelbarrow on the scales empty and then balanced it with a few washers so that when I weighed a barrel of coal, the weights indicated would be net weights. The fireman didn't seem to like it a bit, but I went right ahead. I cleaned the ashpits clean and let the fireman use up every ounce of coal in sight. Then I began to weigh coal for the day.

Several times the chief came around and looked over my outfit, but, as usual, said nothing. Next day I laid on his desk a little memorandum like this:

Total weight of coal burned in 10 hr., 17,288 lb
Total weight of ashes in 10 hr., 2246 lb.
Percentage of ashes, 13 plus.
Boilers in service, 4.
Square feet grate surface in each boiler, 36.
Total sq. ft. of grate surface, 144.
Coal burned per sq. ft. of grate surface per hr., 12 lb.

Next day the chief came out with the little memorandum in his hand, looking it over carefully. He looked at me a minute, looked at the scales, had me put the wheelbarrow on and balance it, then wheel on a barrow of coal and weigh it. It averaged up with my list of loads weighed the day before.

"Mack, let me see your list of weights," said the chief, and I produced it out of my cupboard (a box nailed to the wall, by the way). He looked it over carefully and went away as usual without saying anything.

"Well Mack," said the fireman, "the old man's got your measure all right, all right. I wouldn't like to get what's acoming to you. We've had fourflushers around here like you before, and the usual run is about 6 weeks. O, I guess the chief is on to you, all right. He knows by this time that no kid can show an old hand like me how to fire, for I fired boilers before you were learning your A B C's."

And he got up off his home-made chair to fire up. I must admit that his remarks nettled me somewhat, so after he had fired all 4 boilers to their capacity, I said:

"So you began firing 20 years ago did you?"

"That's what I said—kid!"

"Well, if you did," was my reply, "you do not seem to have made much progress since."

"Why?"

"Because you're still firing."

Just then the chief came to the door and said: "Mack, come in here a minute, will you." and as I started towards the engine room the fireman said:

"Well, kid, I wouldn't like to be in your shoes!"

"Well, I'm wearing them just now, and they fit good." And I went into the chief's little office.

"Sid down."

I did. The chief looked at a few papers on his desk, but somehow or other I didn't feel the least bit anxious.

"Mack, there appears to be something wrong here some place, and I don't know just where it is. You say in your report that we burned 17,288 lb. of coal in 10 hr., or in other words, about 1730 lb. an hour on 144 sq. ft. of grate surface, which you say gives us 12 lb. or so an hour per square foot. Now, at that rate, those boilers are just loafing. Yes, loafing. Why 12 lb. isn't anything. That's just play. Now there is something wrong either with your figures or else with that fireman."

The chief drummed on the desk with his fingers and rocked back and forth in his squeaky chair. Then he continued:

"He told me he couldn't keep her hot unless he had the four boilers on. I've sort o' been leaving that end to him," and he continued the drumming and squeaking. "That looks like a lot o' ash, too, Mack." More pause. "Tell you what you do, Mack," said the chief with decision. "You go right ahead with that wheelbarrow business and make me a nice little report like this every day, if you will, and we'll find out what's what. There's a nigger in the woodpile some place."

"Coalpile?"

"Yes, in the coalpile," he replied. "Say, do you know how often the flues are scraped, Mack?" and I

had to confess I didn't, for I never saw them scraped, although I saw the fireman 3 times a week putting away a piece of ½-inch pipe with a twisted assortment of scrap on the end, and I presume that the fireman had gone through the motions of scraping flues every other day.

"While we are at it, Chief, with your permission, I would like to check the weight of the last car that was just spotted this morning, and see how it agrees with the shipper's weight. It looks to me as if some one had been borrowing some in transit."

"Go to it," said he. "Maybe there are 2 niggers, Mack," and I went back to the task.

It just so happened that there was room enough in one end of the coal bin to take that car load, so I had the yard gang unload it separate and do you know, Father, that when I looked the figures over, I found that where we had been shipped 96,250 lb., all I could get out of it was 89,655, or a loss of an even 3¼ tons! When I showed it to the chief, all he said was:

"Good Lord, what do you think of that!"

I don't know what he said to the fireman, for the noise of a passing train interfered, but I saw the chief and the fireman holding quite an interview over the alleged flue scraper, and just as I came in, I caught, "——— well I don't run the ——— old plant. If you don't want to buy me a decent flue scraper, why it ain't my fault!"

"Yes it is! When you want a new shovel or a new broom you let me know mighty quick, and here you have been poking that useless thing through those flues 3 times a week, instead of daily, with a scraper that is half an inch smaller than the flues!"

Then I went out to the coal bin again. When I came in with another load, the fireman in his rage threw the scoop down on the floor and exclaimed:

"This is the worst ——— ——— dump I ever worked in in all my life. That's just the way. The more you do the more they want you to do. The next chanst I get to get 'nother job I'm a'goin!" and he loaded up the grates for fair—an even 20 scoops of coal to each boiler —I counted them.

Meanwhile, Father, I'm wheeling in coal and wheeling out ashes and I find that it is just as you said, "the more trips you make, the more you learn."

Affectionately your son,
Donald Cameron MacDougal.

HIGH PRESSURE WITH A CENTRIFUGAL BLOWER

CENTRIFUGAL blowers delivering air at over 40 in. of water pressure or nearly 1½ lb. per sq. in., are a new idea, as such blowers are seldom operated at more than 25 in. of water. At the works of The Terry Steam Turbine Co. a new turbo-blower set was recently tested to see if it would meet the guarantees, and the tests of this new design were naturally exhaustive and conducted with greatest care.

This blower set, which consisted of a double-inlet Sturtevant multivane centrifugal blower mounted on the same cast-iron bed with a Terry turbine, and direct-connected by flanged couplings, was to deliver 14,000 cu. ft. of air a minute against a pressure of 40 in. The test was to determine the water rate of the turbine and the closeness of the speed regulation as well as the volume and pressure of air.

During the test, pressure, temperature, and calorimeter measurements were made of the steam just in front of the governor valve, and the exhaust pressure was measured in the exhaust pipe just beyond the outlet of the turbine. The exhaust steam was taken to a surface condenser and the discharge water from the hot well was weighed. The condenser was vented at the top so that it would not produce vacuum at the exhaust of the turbine, which was run non-condensing.

To measure the volume of air discharged by the blower, a long tapered cone having a coefficient of discharge of 0.94 was attached to the outlet, the pressures being taken with a mercury U tube. The blower rated to deliver 14,000 cu. ft. of air a minute, averaged 15,169 cu. ft. for nearly an hour. Steam required for the turbine was not to exceed 7600 lb. an hour, but during this test steam was used at the rate of 6587 lb. an hour, or 13.35 per cent less than the guaranteed maximum.

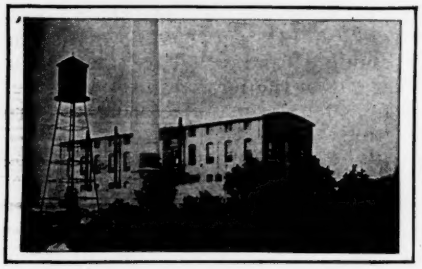
Air pressure maintained was to be 40 in. of water, but for nearly an hour this blower averaged 47.3 in. or over 1½ lb. per sq. in. It reached a maximum during a portion of the test of 51.7 in. Considering the excess in both volume of air and the pressure at which it was discharged, the blower set delivered 27.5 per cent more work than was called for. Reducing the guaranteed conditions to steam consumption per air horsepower gave a result of 58.5 lb. as against the guarantee of 86.13 lb.

In the various tests the pressure at the nozzle inlets of the steam turbine varied from 100 to 106 lb. and the speed from 24.45 to 24.80 r.p.m. The velocity pressure varied from 46.2 to 51.7 in. of water, and the volume of air delivered from 15,000 to 16,000 cu. ft. per minute, the air horsepower from 109.1 to 129. Average values for the test were: Steam pressure at the throttle, 145 lb. per sq. in., at the nozzle inlets, 102.5; pounds of steam used per hour, 65.87; speed, 2463 r.p.m.; velocity pressure, 47.3 in. of water; velocity of air at the outlet, 26,900 ft. per minute; volume of air delivered, 15,169 cu. ft. per minute. Actual air horsepower, 112.6.

A separate test to determine the speed variation gave the following results: The turbine was operated at 2490 r.p.m. without load; with full load thrown on momentarily the speed was 1400 r.p.m., and with the full load soon settled to 2460 r.p.m. This shows that the momentary speed drop was 3.6 per cent and the settled drop only 1.2 per cent. While the blower was running under full load at 2460 r.p.m. the gate was closed suddenly; the speed momentarily jumped to 2575 r.p.m. or 4.7 per cent, but it quickly settled to 2490 r.p.m., or an increase of 1.22 per cent over that at full load.

The suitability of the steam turbine for direct-connected driving of high-pressure blowers is made evident from these results. Such high pressure and close speed regulation were possible with a turbine having the governor mounted directly on the turbine shaft, because in this way failure of intermediate gear is eliminated. The direct-connected governor, running at turbine speed is very powerful and highly sensitive, as shown by the tests.

OFFICERS OF THE Supreme Council of the American Order of Steam Engineers have taken preliminary steps to form an Easton and Phillipsburg branch at Easton, Pa., and to enroll in the membership locomotive, stationary and portable steam engineers. A later meeting will be held to complete the formation of the Easton branch.



Power Apparatus

In Shop and Market

New Ideas in Making, Buying and Selling

BRISTOL'S INK TYPE RECORDING INSTRUMENT

AN illustrated description of Bristol's patented semi-transparent smoked chart recorder has been previously published and although these recorders are fundamentally simple in their construction and hundreds are in daily service, there has been a call for a recorder in which the record is made with ink. To meet the demand for a frictionless ink type of recording instrument to parallel the smoked chart recorder as near as possible in fundamental simplicity and to record accurately fractions of millivolts thus being adapted for use as a recording electric pyrometer, the instrument illustrated herewith has been developed and placed upon the market by The Bristol Co., of Waterbury, Conn.

These instruments have been thoroughly tested out in practical service for 2 yr. past, and are the result of several years of study and experience with an original design of a frictionless ink recorder using a hinged electrical movement carrying a retaining receptacle for marking fluid which extends over the path of the recording tip and is provided with means of periodically making contact with the source of marking fluid and the chart.

Figure 1 shows the recorder ready for operating. Figure 2 is an interior view showing the galvanometer movement case hinged to the back of the instrument and carrying the inking pad in front of the recording arm.

Figure 3 shows the sensitive electrical movement swung to one side for convenience in removing the record and inserting a fresh chart. A capillary gold tube open at both ends is carried at the end of the recording arm at right angles to the surface of the chart. The inking pad is suspended from the case of the electrical movement and is curved to correspond with the arc, covered by the motion of the end of the recording arm.

When the movement is swung back into its operating position as shown in Fig. 2 the recording arm can swing free, accommodating itself to the position corresponding to the delicate current which is to be measured. The clock which revolves the chart at the desired speed also automatically presses the inking pad toward the chart every 10 seconds, bringing 1 end of the capillary tube into contact with the chart and the opposite end simultaneously into contact with the inking pad. A fine dot of ink is left on the chart and the capillary tube is replenished with ink from the pad. The recorder thus carries a constant supply of ink, and its perfect balance, which is important, is always maintained. The electrical movements used in these recorders are made especially for the purpose by the Weston Electrical Instrument Co.

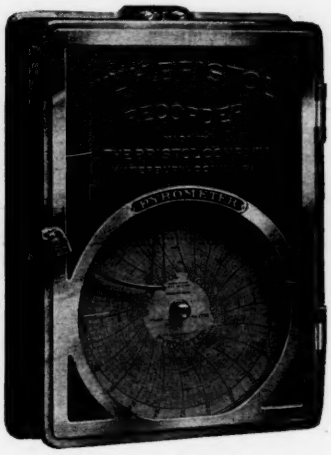


FIG. 1. BRISTOL'S INK TYPE RECORDING INSTRUMENT

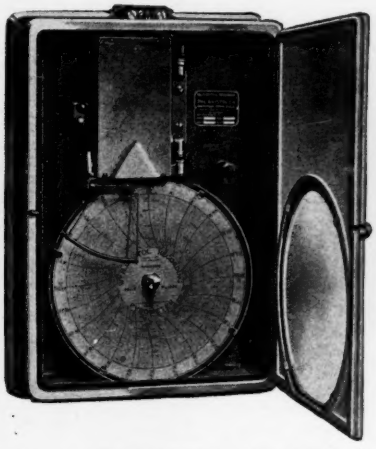


FIG. 2. INTERIOR VIEW OF BRISTOL'S RECORDING INSTRUMENT

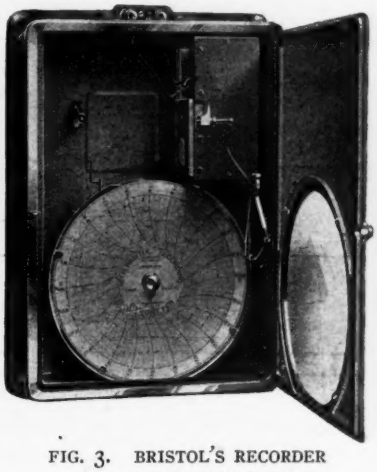


FIG. 3. BRISTOL'S RECORDER READY FOR INSERTING CHART

Although the most important applications of these recording instruments have been for pyrometers, they have also been used for electrolytic research, recording voltmeters, and recording shunt ammeters.

THE GOULDS MFG. CO., of Illinois, has been established as a selling organization to handle the product of the Goulds Mfg. Co., of Seneca Falls, N. Y. O. D. Hogue has been appointed as the head of this selling organization, and will be located in the store at the corner of Ohio and Franklin Sts., Chicago, with a full line of pumps manufactured by the Seneca Falls company.

Previous to his present appointment, Mr. Hogue was at the head of the Goulds Mfg. Co., of New England, handling the selling of Gould Pumps in the New England territory, with headquarters located at Boston.

NEW TWELVE-STORY OFFICE BUILDING

ACCOMPANYING is a photograph showing the new 12-story office building now being erected on the southwest corner of 41st Street and Madison Avenue, New York City, for the H. W. Johns-Manville Co., who will occupy it in its entirety about May 1, 1912, as its general offices and New York salesrooms.

It was the desire of the owners to have a distinctive building, and the early Italian Gothic architecture was selected; a style of architectural treatment which has not, heretofore, been employed for buildings of this character.

Details of the 2 facades are adapted from various Italian examples. The three lower stories are of

NEW HOME OF H. W. JOHNS-MANVILLE CO.

limestone and the upper stories of gray-brown Roman brick and terra cotta, with various light-colored marbles worked in panels. Under the cornices are various colored marble panels in terra cotta frames.

Entirely around the top of the building, will run the cornice, of copper, which will be accentuated by treating with silver, gold and colors. Large windows on the lower stories will be of bronze, and the vestibule and entrance hall of Italian marble.

The entire ground floor, which will be devoted to the retail department, will be furnished entirely in marble and Caen stone, and the soffits of the beamed ceiling will be brought out in color from various Italian examples.

There will be a mezzanine gallery with bronze rails and a marble stairway, with bronze railing, leading up from the first to the second floor. Each floor will be devoted to one or more departments, the executive offices occupying the eleventh floor, while the twelfth floor will be used as a sample and exhibition room.

The building has been designed so that all four sides will be attractive. It will be known as the "Johns-Manville Building" and will have the unique distinction of being one of the few 12-story structures to be entirely occupied by a manufacturing concern for office purposes only.

The building will be of fire-proof steel construction throughout, and will contain 2 Otis passenger elevators of the latest type. Each floor will have an area of 2,500 sq. ft. or a total area for the 12 floors and basement, which will extend under the sidewalks, of 34,500 sq. ft.

An unusual feature connected with this building will be the fact that the tenant manufactures and will furnish a considerable part of the equipment of the structure. Among the various materials which the H. W. Johns-Manville Co. will install will be the following: J-M Asbestos roofing, J-M Asbestos plaster, J-M Linolite system of lighting, J-M Conduit for wiring, Flushometers, J-M Sanitor seats, Electrical accessories, Waterproofing, Keystone hair insulator, J-M Asbestos wood, fire extinguishers, J-M Asbestos-Sponge felted and J-M Asbestocel pipe coverings, etc.

Fire-proof materials will be used throughout the structure. Modern systems of heating and ventilating will be employed, and the building will rank, architecturally and otherwise, among the handsomest and most substantial office structures in New York.

DEFLOCCULATION

IN an address before the London Society of Chemical Industry, Doctor Edward G. Acheson outlined the process which bears the formidable looking title at the head of this article, and which has resulted in a number of new industrial methods.

It seems that his first work in reducing materials to an extreme state of fine subdivision was done in 1901, in the effort to get a clay, which would be suitable as a binder for making graphite crucibles. American clay had proved unsuitable, and imported clays from Europe were found much superior, although chemical analysis failed to disclose the cause of the difference.

Doctor Acheson endeavored to find out what produced the variation, and started from the statement found in a book that residual clays were nonplastic, while sedimentary clays were more or less plastic, that is, clay found in its original position did not have the plastic quality. He thought that this change must be due to the agents in the water which carry the clay from one place to another, and laid it to the vegetable matter in the water. One of the early experiments was to treat the clay with a solution of tannin which increased both the tensile strength and the plasticity. He found that this treatment increased the strength some 240 per cent, and going back to the old record of brick making by the use of straw found in Exodus, he boiled straw with water and the resulting reddish brown liquid was mixed with clay. He found that the result was like that produced with tannin, which indicates that the Egyptians had discovered this strengthening effect.

Continuing the experiments in 1906 with graphite, he was able to subdivide this by the use of vegetable matter so as to produce the deflocculating effect and hold the finely divided material in suspension in water although the graphite is 2.2 times heavier than water. He has been able to obtain this same effect on alumina, silica, lamp black and siloxicon. The deflocculating effect can be produced with a long list of organic bodies such as tannin or organic substances containing

tannin, also with solutions containing the gum of the peach and the cherry tree or extracts from straw and grass.

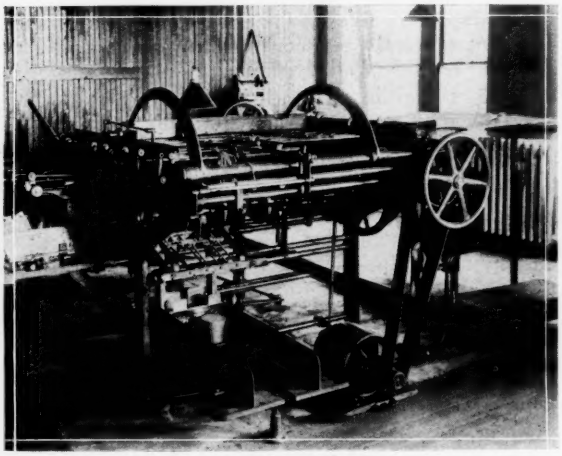
The deflocculation can be overcome and flocculation or gathering into masses again produced by the addition of salt, lime water, acid or any one of the substances known as electrolytes; even the bubbling of weak carbonic acid through the water carrying deflocculated graphite will cause sedimentation.

Doctor Acheson believes that in the deflocculated state the substances are reduced to the ultimate molecules, each molecule of the substance being surrounded by an envelope of organic jelly. Some experimnts conducted by Jerome Alexander of New York, at Doctor Acheson's request indicated that the particle of deflocculated graphite is of a diameter of 75 one millionths of a millimeter, so that it would take slightly more than 13,000 of these particles to extend one millimeter in length. The deflocculated particle is therefore 1/1000 as large as the particle of ground graphite from which it is formed, and Doctor Acheson believes that the separation does not stop short of the colloidal state, the freeing of the molecule.

MOTOR DRIVE IN A PRINTING PLANT

THE shop of Kohn & Pollock, Baltimore, Maryland, is an excellent example of the improvement to be secured from the electrification of a printing plant.

This plant was formerly located in comparatively cramped quarters where the lighting facilities were not the best and power was supplied to all of the



MOTOR DRIVE FOR FOLDER SHOWING ARRANGEMENT OF CONTROL BOX

machines through one shaft. Some time ago, however, they installed individual motor drive throughout the plant.

The electrical equipment of the plant includes 15 constant-speed, direct-current Westinghouse type R motors, aggregating 21.5 hp. The various machines and the motors driving them, together with the speeds at which they operate are given below:

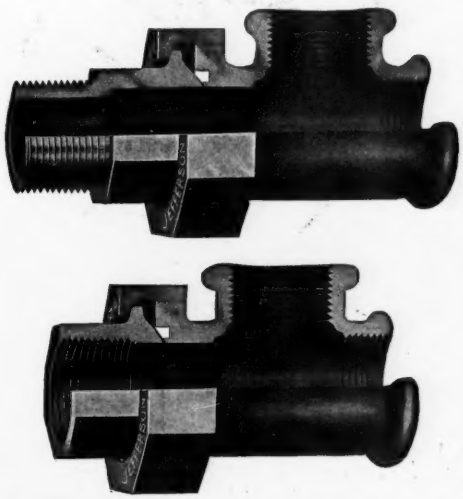
Two Miehle presses, 5 hp., 1000 r.p.m. compound-wound motors; one pony Miehle press, 1¼ hp., 830 r.p.m. compound-wound motor; three Colt Armory presses, 3½ hp. 460 r.p.m. shunt-wound motor; three Chandler and Price presses, 1⅓ hp. 715 r.p.m. shunt-wound motors; two stitchers, ¼ hp. 460 r.p.m. shunt-wound motors; two cutters, 2 hp. 1240 r.p.m., compound-wound motors; one folder 38 by 50, 1¼ hp. 1280 r.p.m. shunt-wound motor.

All of the motors were furnished by the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.

THE NEW JEFFERSON UNION

MAKERS of the original Jefferson Union, whose works are in Lexington, Mass., have put upon the market 2 types of union tees which are decided additions to their line of union fittings. The advantages of the Jefferson Union tee are as great as those of the Jefferson Union elbows, saving money and labor, and making many jobs easy that would be difficult with the old style fittings.

These new tees are made with the union either on the run or on the outlet and with the union end threaded



JEFFERSON UNION MALE AND FEMALE TEES

either male or female. The male and female union tee takes the place of an all female union, nipples and an ordinary tee, thus saving 3 pipe joints, considerable expense, and at the same time assuring the best possible result.

The Jefferson Union tee is heavily constructed, of malleable iron, which is not subject to stretching. The brass seat-ring which is cut from seamless brass tubing, and is ground to make a ball joint, is securely seated in a channel cut in the iron, and is set back from the inner runway of the fitting. Octagonal pipe ends are provided with all Jefferson Unions.

Absolutely tight joints are assured by the use of Briggs' standard taper pipe threads. The nut threads are coated with graphite, which not only prevents corrosion, but serves as a lubricant and makes it easy to disconnect a Jefferson Union, even after long use. Like all other Jefferson Unions, the union tees are easily applied because of the liberal play between the nut and the swivel end. The name Jefferson is on the nut or flange of every genuine Jefferson fitting, as made by the Jefferson Mfg. Co., of Lexington, Mass.

C. W. STONE has been appointed manager of the Lighting Department of the General Electric Company, to succeed C. D. Haskins, deceased.

HEELY BOILER TUBE SPREADER TOOLS

EFFICIENCY of the Babcock and Wilcox type boilers is maintained not alone by keeping the tubes free from scale, but the baffle walls which deflect the hot gases must be kept intact, and as these walls are built in of fire brick between the tubes when the boiler is being erected, it is a difficult matter to replace the brick when they disintegrate or are removed to put in new tubes.

With the best of care these walls give way in a few years, due to the action of the heat, and heretofore

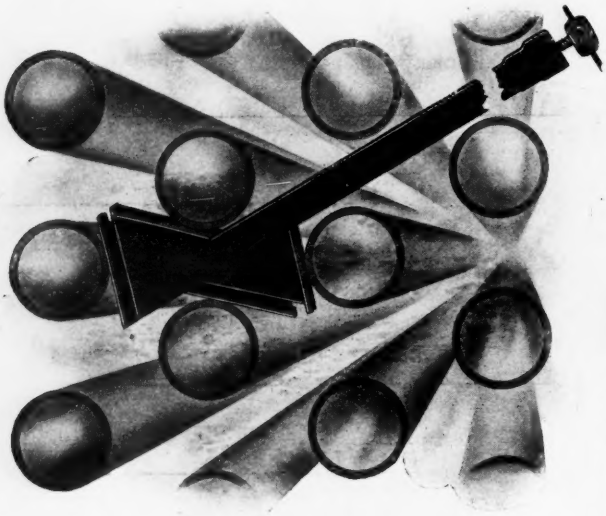


FIG. 1. TUBE SPREADING TOOL

it has been found necessary to use split brick or to chip the edges to set the new brick into place. Using this method, it has been found impossible to repair the baffle walls and make nearly as good a job as the walls built when the tubes were put in place.

FIG. 2. TOOL FOR PLACING THE BRICK

A set of tools for spreading and placing these baffle brick was invented a few years ago by Patrick Heely, who was for 20 yr. erecting engineer for the Babcock and Wilcox Co. Recently Mr. Heely has secured patents on an improvement to these tools and these are illustrated in Figs. 1 and 2.

Figure 1 shows the tool used for spreading the tubes, made with an adjustable spreader head. The moveable part is operated by a threaded stem that screws into a nut on the inside of the handle and is operated by a rod on the end. The working ends of the spreader are provided with large faces which prevent any possible injury to the tubes. With the tubes spread in this manner it is a simple matter to remove an old baffle wall and replace it with new baffle brick without injury to either tubes or bricks.

Figure 2 illustrates the tool used for replacing the baffle brick in position, which consists of a gripping member adjustable from the end by a threaded rod which passes through a nut on the inside of the handle. With the brick gripped in the jaws, the tool is inserted between the boiler tubes and when in place the moveable jaw is drawn back and the tool removed.

By the use of these 2 tools the baffle brick can be replaced whole, using the 4-in. standard brick the same as first installed and the baffle walls left in as good condition as when the boiler was originally erected. These tools are manufactured by the Heely Tube Spreader Co., New York City.

CALORIZED ELECTRIC SOLDERING IRON

USE of the ordinary soldering iron has 2 serious drawbacks—the impossibility of keeping it hot continuously, and the rapid wasting away of the copper. Development of the electric soldering iron obviated the former, furnishing an iron which not only stayed uniformly hot all the time, but one in which the heat intensity could be easily regulated by the mere turning on or off of the current. The second fault, that is, the rapid wasting away of the copper, still remained, to a large extent, necessitating frequent renewals, and consequently making no reduction in the cost of maintenance.

It is, therefore, of much interest to metal workers to know that many experiments made in the research laboratories of the General Electric Co. to mitigate this fault, has resulted in the discovery of a process of treating the copper which renders the latter nonoxidizable under high heats and noncorrodable by the acids used in soldering. Furthermore it reduces to a minimum the dissolving action of the molten tin, with which the working tip must always be kept coated.

This "calorizing" process or method of treatment does not merely coat the surface of the copper with a thin layer of nonoxidizable or noncorrodable substance, liable to scale off under the effects of heat and acids, but actually changes the characteristics of the copper to an appreciable depth. Thus the durability or practical working life of the copper is increased to such an extent as to provide a soldering iron of maximum economy and effectiveness.

RAPID ENGINE BUILDING

WHEN the Mesta Machine Co. established the record a short time ago of building a heavy Corliss mill engine and mill for the Sellers Manufacturing Co. of Chicago in exactly 26 days, it was thought that the limit of speed had been reached on this class of heavy machinery building.

This record has again been broken by the Mesta Machine Co. in building a 32 by 48-in. Corliss engine for the American Sheet & Tin Plate Co.'s plant at

Martin's Ferry, O., to replace an old engine that had broken down beyond all repair.

The order was placed with the Mesta Machine Co. on account of its reputation for record breaking engine building, and shipment was promised in 3 weeks from receipt of order. The order was received on Oct. 16, 1911, and complete shipment was made in 16 days, and 14 days later the engine was put into operation, thus making 30 days from the date the engine was ordered until the new engine was driving the mill.

No part of the engine was in stock, all parts, including the forgings, had to be made from the raw material. Before the plant was equipped with steam hydraulic forging presses it required all of 16 days to have a set of forgings delivered to the shop, and only a few years ago it required more than that time to make a casting of a Corliss cylinder of this size.

REGULATIONS FOR ENGINEERS IN ATLANTA, GA.

COMMISSIONER Waters in conference with the Board of Examiners of engineers and firemen, compiled a new set of rules which have been adopted by the board and which contain the following provisions: For boilers carrying pressure not exceeding 20 lb., and equipped with automatic regulator, and which are quarterly inspected by some insurance company, a special license is granted for a fee of $5, and for a time of one year from date of issue, except that boilers in private residences, public schools, charitable institutions and churches, are granted license without fee.

All licenses must be renewed yearly, and if presented to the board before expiration, a new license will be given without charge, but, if the license is allowed to lapse a fee of $1.50 is charged for renewal.

Application for license must be made in writing, the applicant being recommended by 3 licensed engineers, and no engineer or fireman shall operate any type of engine or boiler not specified in his license.

The fee is $5 for each examination of a fireman or engineer, and $1.50 for each renewal of license, except as provided above for the renewal of old licenses, all which were made to expire on December 31, 1911.

Revocation of license may be ordered for fraud or misrepresentation when obtaining the license, or for neglect of duty, incompetence or insobriety, or for refusal to carry out such rules and regulations as the Examining Board may make.

NEWS NOTES

THE C. E. SQUIRES CO., E. 40th St. and Kelley Ave., Cleveland, O., maker of Squires Steam Traps and Specialties, is building a new addition to its new factory and installing additional machinery and power equipment on account of continued increase in business. The new building is of modern brick construction and gives increased space sufficient to take care of all demands.

JACQUES ABADY, a director of the English firm of Alexander Wright & Co., Ltd., engineers and manufacturers of measurement and control apparatus, sailed for London November 17, after a 2 weeks' visit with Alexander Wright & Company's American Branch, the Precision Instrument Company of Detroit. In addition to his business activities, Mr. Abady is a Barrister, is Chairman of the Works Committee of the Council of Westminster, and is the author of "Abady's Gas Analyst's Manual," published in this country; "Coal and Common Sense;" "The ABC of Combustion," and other contributions to technical literature. He is one of the co-inventors of the Simmance-Abady combustion recorder, Simmance-Abady vacuum and pressure gages, and other apparatus for testing various conditions of steam, gas, water and air. His visit was partly with the object of discussing several new inventions, which have passed the experimental stage, and which will shortly be on the market for general use in steam and gas plants.

ARRANGEMENT HAS BEEN made by the Lehigh Council of the American Order of Steam Engineers for the use of the grandstand building at the fair grounds, Allentown, Pa., for the National Convention of the order to be held June 3-7, 1912. The committee having the matter of arrangements for the convention in charge consists of A. P. Driesbach, chairman; Solomon Fehnel, secretary; John Burley, treasurer; Ed. Brader and O. M. Baer. The large dining-room on the grandstand will be used as convention hall and exhibit room for the American Supplymen's Ass'n. Plans are in progress for a 5-days meeting, with programs of the sports in front of the grandstand during the afternoon, and entertainments in the evening. Mornings and early afternoons will be devoted to the work of the convention. Lewis G. Schlehner, chief engineer of the Sauquoit Silk Co., of Philadelphia, will preside as supreme chief engineer, and the work of the Supplymen's Association will be presided over by Harry J. Winner of Philadelphia, president, and Fred L. Jahn, secretary. Chas. E. Sanville is in charge of the exhibits. Hotel Allen will be the headquarters for delegates during their stay in the city.

R. G. VON KOKERITZ & Co., 114 Liberty Street, New York, announces that on and after Jan. 1, 1912, the selling department of the firm will be taken over by the Durabla Manufacturing Co., with offices at the same address and the following officers: C. B. Hill, president; R. G. Von Kokeritz, vice-president; N. P. Hill, secretary and treasurer.

CATALOG NOTES

FROM THE INTERNATIONAL HARVESTER CO. OF AMERICA, through its Chicago office, we have received the almanac and encyclopedia for 1912, giving the usual data to be found in such a publication, together with much information of use to those engaged in agricultural pursuits. There are also special articles on Seed Testing, Rotation of Crops, Raising of Alfalfa, Dairying and Sanitation in the Country. Accompanying this is a set of attractive calendars in colors which are reproductions from oil paintings; copies may be secured by writing to the International Harvester Co., Chicago, Ill.

GOULDS AIR PRESSURE AND VACUUM PUMPS, made by the Goulds Mfg. Co., of Seneca Falls, N. Y., are interestingly described in a convenient pocket booklet, which tells all about the different styles and their use.

OILDAG, made of deflocculated graphite, diffused in oil, is a new lubricant whose uses are shown in a copyrighted booklet issued by the International Acheson Graphite Co., of Niagara Falls, N. Y. The reading of this booklet is likely to be a means of saving dollars and difficulties to any engineer.

DIAMOND CHAINS AND SPROCKETS, as manufactured by the Diamond Chain & Mfg. Co., of Indianapolis, Ind., are fully described in a treatise by Lucius M. Wainwright, which has recently been pub-

lished by the company. This book tells of the application of chains and sprokets, the method of designing a driving chain, sizes and proportions of sprockets, chair of chains, the use of chains on motor cars, and the details of the different chain drives and styles of driving chains manufactured by the Diamond Company.

HYDRAULIC JACKS, made by the Duff Mfg. Co., of Pittsburgh, Pa., are illustrated and described in a folder just received, which states as the advantages, simplicity, dependability and light weight. Catalog may be had by writing to the manufacturers, 50 Church St., New York City.

FROM THE American Blower Co., of Detroit, Mich., comes an interesting little folder shaped like a sirocco fan, and having on the outside an exterior view of the fan ready to run. On opening up a detailed view of the wheel is shown with explanation of construction and advantages of this type of wheel.

BULLETIN 103, from the Goulds Mfg. Co., of Seneca Falls, N. Y., is devoted to the vertical, single-acting triplex plunger pump, and is full of live information about this important type of apparatus. It gives the specifications of the Goulds pumps, shows in detail the parts and the arrangement of the different styles manufactured, gives tables of capacity in gallons per minute, sizes of plungers and of connecting pipes. It is an interesting and useful bulletin.

THE GENERAL ELECTRIC COMPANY has just issued Bulletin No. 4899, illustrating and describing its Expulsion Fuses and Fuse Holders. These are for use on circuits having voltages up to and including 110,000.

IN A NUMBER of recent instances, it has been necessary for the postoffice to refuse to handle expensive catalogs which contained unmailable matter. A prize-giving scheme, which comes under the classification of a lottery or any statement forbidden by statute or regulation, makes a catalog unmailable. The department states that those contemplating the issuing of a catalog in which there may appear anything of which they doubt, should be submitted to the local postmaster before printing, so that expense and difficulty may be avoided.

INGERSOLL-RAND CO., 11 Broadway, New York City, has issued Form 3210, bulletin of 12 pages, descriptive of Class NE-1 power-driven, single stage, straight line air compressors. This compressor consists of an air cylinder supported by a main frame with a piston operated by means of a center crank shaft with a belt wheel on one side and a flywheel on the other. Shaft and wheels can be reversed in the bearings if the belt wheel is preferred on the other side. Air inlet valves on the smaller machines are of the "Direct Lift" type; on the larger machines "Hurricane Inlet" valves are standard. "Cushioned Direct Lift" discharge valves are standard on all sizes. The catalog shows several views of the machine in section and gives tables of sizes and capacities.

FOR BETTER CROPS, is the caption that stands beneath an attractive cut on the embossed cover of a booklet issued by the International Harvester Co., and this simple phrase tells the story of a great purpose. It is the business of the International Harvester Co. to make and sell farm machinery, hence that company, is interested in having bigger crops, because that will call for more machinery to care for and harvest them, but the present book is distinctly altruistic, and is a treatise by authorities among the most prominent in the country on agricultural subjects, discussing in simple language, but with scientific accuracy, how to increase the fertility of the soil and how to solve the problem which is rapidly approaching of supporting the world's population from the world's farm lands. The book covers not only grain growing, but the corn crop, alfalfa culture, farm power, hay making, care and protection of farm equipment, the relation of farm machines to progress. It has over 150 pages filled with vital and valuable information, which, if carefully studied and acted upon, is bound to increase the prosperity of our country greatly. We congratulate the International Harvester Co. on the production of such a book and the farmers of the country on having a friend sufficiently interested in their welfare to place this material before them without charge. It is a book which anyone who is considering a migration "back to the land" at any future time will do well to read.

THE GENERAL ELECTRIC CO. has just issued Bulletin 4882, describing its Enclosed Flame arc lamps. This lamp utilizes the impregnated, or so-called flame carbon electrode which gives remarkable illuminating efficiency, and this, together with the simplicity of the lamp mechanism, renders it ideal for the economical illumination of large areas. The lamp is so designed as to admit of the use of any of the standard makes of flame carbons available.

BULLETIN 4871 describes the General Electric Company's mercury arc rectifiers for battery charging, and supersedes that company's previous bulletin on the subject.

The General Electric Company has issued Bulletin B 3038, entitled "Electricity on the Farm." The bulletin is divided into brief chapters, each covering a specific use for electricity on the farm, the various descriptions of motor applications being accompanied by illustrations of electrically operated farm machinery in actual service. The bulletin is attractively bound and carefully illustrated, and owing to the immense economic importance of the subject treated, should prove of considerable interest to the farmer, consulting engineer and central station manager.

Bulletin No. 4817, issued by the General Electric Company, describes that company's 75-hp. direct current commutating pole railway motor which represents the latest construction in this class of apparatus.

KONOLD STEAM AND HYDRAULIC SPECIALTIES, as made by M. J. Konold Co., of Pittsburgh, are illustrated in the 1911 catalog A, just sent out by the company. Among other novelties are the Konold Compound Valve steam trap having a combination conical and ball valve, the swivel joint for steam, air or water lines, and the Konold ball valves made up as straight stop valves, for angle valves for blowoff valves, and for hydraulic use.

STEAM TURBINE CENTRIFUGAL Pumps and Other Centrifugal Machinery is the title of a 32-page booklet issued by by the DeLaval Steam Turbine Co., of Trenton, N. J., illustrating and describing briefly the several lines of machinery manufactured by that concern, including single stage turbine for driving machinery of all kinds and for rope and belt transmission; turbine-driven centrifugal pumps for water works, for general water service in industrial plants and for boiler feeding, hydraulic pressure work, etc. Copies of this booklet will be sent upon request to those interested.

TRADE NOTES

THE KERR TURBINE CO., Wellsville, N. Y., advises that over 700 of their machines, aggregating more than 50,000 hp., are in active service and that more unfilled orders are now booked than at any previous time in the history of the company. Although their plant has been materially enlarged, a night shift has been necessary for the past 2½ yr. Among recent orders are the following: One 350-kw. turbo-alternator for the Brooklyn Refiinery of the Standard Oil Co.; 2 2800 gal. per min. turbo-pump units for Tidewater Oil Co.; 2 75-kw. and 1 35-kw. lighting sets to American Shipbuilding Co. for the new steamer "City of Detroit;" 2 75-kw. lighting sets for waterworks service, City of Chicago; one 60-b. hp. turbo-generator with prony brake attachment for the University of Melbourne, Australia (this unit takes steam at 200 lb. gage, with 200 deg. superheat, and exhausts to 28 in. vacuum); 1 215-hp. turbo-blower for Peoples Gas Light & Coke Co., Chicago (the tenth set of this size ordered by these people); 2 underwriter fire pumps driven by 200-hp. Kerr turbines for Stieger & Sons Piano Factory, Stieger, Ill.; 1 fire pump driven by 265-hp. Kerr turbine for B. M. Osborn Co., Chicago. This last named will be the only turbine-driven fire pump in the city of Chicago.

CHAS. A. SCHIEREN COMPANY, New York, N. Y., received the following letter from a satisfied customer, which shows the trying conditions under which Duxbak will work: "You sent us on trial 69 ft. of 6-in. single Duxbak waterproof leather belting with the expressed understanding that we were to give it a complete trial. We have used this belting in a room where condensing steam is settling on it most of the time, and we now report that it has given us satisfaction in every respect. We gladly enclose our check to cover. Thanking you for the time allowed, we are, San Marcos Oil & Gin Co."

THE FRANCE PACKING COMPANY of Tacony, Philadelphia, is now represented in almost every large city in the United States, as follows: New York City, 39 Courtland St.; Baltimore, Md., 330 Law Bldg., Jefferson Young, representative; Chicago, 231 No. 5th Ave., Frank Smith, representative; San Francisco, Cal., T. L. Tomilson, 24 California St.; Los Angeles, Cal., W. P. Story Bldg., John Proper, representative; Seattle, Wash., Guy Thompson, 309 Powles Bldg.; Portland, Ore., 83 First St., W. E. Wilkinson, representative; San Antonio, Tex., 114 E. Poplar St., A. C. Stucky, representative; Denver, Col., Geo. A. Camblin, Albany Hotel; Salt Lake City, Jones & Jacobs, representative; St. Louis, Mo., J. B. Meyer Co., representative; Newark, N. J., 143 Commerce St., Phil Scanlan; Joplin, Mo., H. C. Cole, 408 Joplin St.; St. Joseph, Mo., 216 So. 7th St., Furbech & Hurt, representatives; Kansas City, Mo., Kansas City Eng. Co., representatives; Minneapolis, Minn., Garbeet & Schneider, representatives. Any inquiries referring to France Packing will be promptly taken care of if sent to any of the above representatives.

SALES RECENTLY MADE by The Bruce-Macbeth Engine Co. include: One 75-hp. 4-cylinder natural gas engine installed for the Olympic Theater, Pittsburgh, Pa.; one 115 and one 35-hp. engine for operation on natural gas at the plant of the Harshaw, Fuller & Goodwin Co., Elryia, Ohio; one 35-hp. natural gas engine for electric lighting and storage battery work at the Prospect Garage, Cleveland, O.; one 55-hp. engine installed for the Pittsburgh Steamship Co. at Conneaut Harbor, Ohio; one 55-hp. engine direct connected to triplex pump at the plant of the Bellevue, Ohio, Water Works; one 300-hp., 4-cylinder producer gas engine at the plant of the Patapsco Electric & Mfg. Co., Ellicott City, Md., to be used for municipal lighting; one 55-hp. natural gas engine installed at the Canton Lumber Co., Canton, O.; one 35-hp. engine installed for the Superior Drop Forge & Mfg. Co., Cleveland, O.; one 75-hp. producer gas engine for the plant of Messrs. J. D. Manor & Co., New Market, Va.; 75-hp. natural gas engine for the Consumers Ice & Cold Storage Co., Lexington, Ky. (second order); two 75-hp. engines for belting to generators at the plant of the C. L. Flaccus Glass Co., Tarentum, Pa. (fourth order); one 135-hp. gas engine installed by the Exide Battery Depots, Inc., Cleveland (second order); one 65-hp. engine for the Boston Consolidated Gas Co., Boston, Mass.; one 80-hp. engine to the Perfection Spring Co., Cleveland, O. (second order); The Van Dorn Iron Works, Cleveland, one 150-hp., 4-cylinder natural gas engine; one 300-hp. engine, 4-cylinder, for operation on natural gas, for municipal lighting at the plant of the City of Canal Dover, Ohio (second order); one 150-hp. natural gas engine to the H. C. Fry Glass Co., Rochester, Pa.; one 250-hp. natural gas engine to be installed at The Hotel Southland, Dallas, Texas, for elevators and lighting; one 65-hp. twin cylinder natural gas engine for the Niagara Shoe Co., Buffalo, N. Y.; one 115-hp., 4-cylinder natural gas engine for The Prairie State Incubator Co., Homer City, Pa.; two 135-hp. engines for the Cameraphone Building, Pittsburgh, Pa.; one 115-hp., 4-cylinder engine for the Consolidation Coal Co., Inc., Fairmont, W. Va.; one 350-hp. natural gas engine installed at the plant of the Monongah Glass Co., Fairmont, W. Va. (sixth order).

THE NEW YORK, NEW HAVEN and Hartford Railroad Co. is to install 2 more Taylor stokers in its Bridgeport plant. These 2 stokers are in addition to the 2000 hp. of Taylor stokers already in operation.

RECENT INSTALLATIONS of the Diesel engine, completed by the Busch-Selzer Engine Co., of St. Louis, are as follows: Sherman Gas & Electric Co., Sherman, Tex., 2 225-hp. in use for 6 yr., 1 225-hp. new; Cleburne Electric & Gas Co., Cleburne, Tex., 2 225-hp. in use 1 yr., 1 225-hp. new; Compagnie Generale des Phosphates de la Floride, Pembroke, Florida, 5 225-hp. new; Menasha Municipal Light Plant, Menasha, Wis., 2 75-hp. in use 5 yr., 1 225-hp. new; Hugo Ice & Light Co., Hugo, Okla., 1 225-hp. new; Arkansas Cold Storage Co., Little Rock, Ark., 2 120-hp.; Thibodaux Municipal Plant, Thibodaux, La., 2 120-hp.; City of Granite Falls Minn., 1 170-hp.; Hershey Chocolate Co., 2 225-hp.; City of Mansfield, Mass., 2 120-hp. in use 5 yr., 1 225-hp.; Bronx Ice Plant, A. B. B. A., New York, 2 225-hp. and 1 120-hp. in use 1 yr., 3 225-hp. new.

A REMARKABLE TEST was recently made of a wood rim, iron center pulley at the plant of the Dodge Manufacturing Co. William Slater Mills, of Jewett City, Conn., had ordered 2 pulleys to have a rim speed test for one hour at 8000 ft. a minute; one pulley, 100 in. diameter by 22 in. face, the other 74 in. diameter, by 22 in. face. The pulleys were to transmit 340 hp. at 6700 ft. per minute rim speed with a 21-in. belt. The test was made with 9817 ft. a minute for the larger pulley, and 9880 ft. a minute for the smaller pulley, and both stood up successfully. The pulleys have now been in service for some 3 months, giving entire satisfaction. In this connection it is interesting that some years ago a pulley of similar construction

was built 46.5 in. diameter by 16 in. face, and ran at 10,000 ft. a minute, and a companion pulley built especially for further testing was run at the speed of 29,200 ft. a minute or a little over 5.5 miles.

YORK MANUFACTURING CO. has recently made the following sales: Frank L. Strong, Manila, P. I., one 8-ton refrigerating plant to be installed for the New Manila Hotel, Manila, P. I.; L. F. Loree, West Orange, N. J., one 4-ton refrigerating plant; New Alexandria Supply Co., New Alexandria, Pa., one 4-ton refrigerating plant; Westmoreland Hospital Assn., Greensburg, Pa., one 2-ton refrigerating plant; Chas. F. Rantz, New Orleans, La.; one 35-ton refrigerating machine, to be installed for the Hammond Creamery Assn., New Orleans, La.; John L. Hill, Smithville, Texas, one 40-ton high-pressure side, and 10-ton freezing system; Louis Saladin, Brooklyn, N. Y., one 8-ton refrigerating plant; Commercial Bank Bldg., Charlotte, N. C., one 2-ton refrigerating plant for cooling drinking water; William Zaiss, Bath Beach, N. Y., one 4-ton refrigerating plant; United Iron Works, Oakland, Cal., one 8-ton refrigerating plant, to be installed for the California Fruit Canners Assn., San Francisco, Cal.; Uhrichsville Ice Company, Uhrichsville, Ohio, one complete 30-ton ice making plant; Samuel Alboum, Newark, N. J., one 90-ton refrigerating machine; Geo. A. Fuller Company, New York, 2 35-ton refrigerating machines, 18-ton freezing system and brine piping for boxes to be installed for the Plaza Copley Hotel, Boston, Mass.; Elder & Wells, New York, N. Y., one 175-ton cross compound refrigerating machine and high-pressure side, and one 100-ton freezing and distilling system; Anchor Brewing Company, Tarentum, Pa., one 125-ton high-pressure side in addition to repairs to present plant.

PRACTICAL ENGINEER CLASSIFIED ADVERTISEMENTS

Advertisements in this section are inserted under regular headings at the rates of 30 cents per line. About nine words make a line. No display type allowed, but the first three words may be set in capital letters. Minimum space sold, two lines.

Under classification, "Positions Wanted," advertisements not exceeding four lines will be inserted for subscribers once free of charge.

To insure proper classification, copy must reach this office 10 days preceding publication.

Positions Wanted

POSITION WANTED—As chief engineer of electric plant in some state institution. 17 years' experience with electric plant and water works. Can do own repair work. Sober and industrious. Middle west preferred. 42 years of age, Best references. Ready at once. L. G. Utley, Chapel Hill, N. C.

POSITION WANTED—Engineer with Fifteen years' experience as chief in charge of large Ice and Electric Steam plants. Positive and centrifugal pumps, steam Heating, Erecting and Repairing. First Class License and References, Strictly sober. Change desired. Address Box 198, Practical Engineer Chicago, Ill.

POSITION WANTED—As assistant engineer. Ten years' experience with engines and boilers, also some experience with D. C. generators. Steady, sober and industrious. References. F. F. Ninman, Shawano, Wis. 12-2

Help Wanted

SELLING AGENTS WANTED in important centers for Betson Plastic Fire Brick. See page 112 in this issue. Betson Plastic Fire Brick Company, Rome, New York. 12-tf

COMPETENT AND EXPERIENCED stoker erectors at once. State age, experience, reference and salary expected. Give full details. Address Box 168, Practical Engineer, Chicago Ill. tf.

HELP WANTED—ENGINEER WANTED in every city and town to instruct our customers in indicator practice. If you have a fair working knowledge, we will "do the rest." Good pay to reliable, intelligent men. See our adv. on page 96. Write for particulars. Lippincott Co., Newark, N. J.

ENGINEERS AND MECHANICS—To make big money selling Incomparable "ZIZ" Hand Soap. A 10-cent can will instantly remove more dirt and stains from the hands than four cakes of any soap made, and will not injure the most delicate skin. Small sample free. Byram Mfg. Co., Box 3133, Boston, Mass.

AGENTS WANTED TO HANDLE ESTABLISHED steam specialty which is known all over the country. Can be handled with non-conflicting specialties. Will give exclusive agency only for amount of territory actually covered by agent or his salesmen in the following states: Virginia, North Carolina, South Carolina, Oklahoma, Wyoming, Georgia, Arizona, New Mexico, Montana, Idaho, Florida, Arkansas, North Dakota, South Dakota. Address Post Office Box 1754, Pittsburgh, Pa. 9-tf

BOILER MEN—Several energetic men who are familiar with the operation of steam boilers can secure good positions as salesmen on straight salary and in good territory. In making application, state age and experience. Address Box 197, care Practical Engineer. 12-2

Wanted

IF YOU ARE a night engineer, spend a few hours each day taking subscriptions for Practical Engineer. You will be paid well. Write the Subscription Dept. They will start you in at once. 1-1

WANTED—5,000 STATIONARY ENGINEERS to send us their name and address. A good proposition open to each one. For full particulars, write Henry W. Lord, 7 S. Greene St., Baltimore, Md. tf

For Sale

FOR SALE—INDICATOR, REDUCING WHEEL, planimeter best make in fine order. Examination allowed before payment. Price low, in fact a sacrifice. Address Mrs. N. L. Browning, East Orange, N. J. tf

Patents and Patent Attorneys

PATENTABLE IDEAS WANTED—Send for 3 free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. 7-tf

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 608 F. St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had and the exact cost. Send for full information. 10-tf

PATENTS—C. L. Parker, late Examiner U. S. Patent Office, Attorney-at-law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the inventors. Handbook for investors sent upon request. 186 McGill building, Washington, D. C. 4-tf

Miscellaneous

MAKE MONEY on the side. Here's your chance to pick out some money for yourself. Get subscriptions for Practical Engineer. It pays well. Just drop a line to the Subscription Dept. They will tell you how. 11-3

EVERY ENGINEER should be posted regarding the new system of vacuum heating installed without payment of royalty; I have valuable information; write to-day. C. P. Monash, 1413 W. Jackson Blvd., Chicago, Ill.